Manual for the Emergency Sanitation and Water Auxiliary Training Program

1) Organization and Operation of Emergency Sanitation Services.
2) Organization and Training of Water Main Emergency Repair Crews and Auxiliary Personnel Assigned to Emergency Water Service Duties.
3) Lectures and Lesson Material for Use in Water Works Auxiliaries Training Course.

Prepared by

Division of Water Main Emergency Repairs

w York (State) State Office of Civilian Protection

under

The Mutual Aid Water Supply Program

of

New York State

Earl Devendorf

State Water Supply Coordinator

New York State War Council

and

Associate Director, Division of Sanitation

New York State Department of Health

Albany, N. Y.

NEW YORK STATE WAR COUNCIL

Emergency Sanitation and Water Auxiliary Training Program

Cooperating Agencies

The New York State Mutual Aid Water Supply Program

and

Division of Water Main Emergency Repairs

State Office of Civilian Protection

EARL DEVENDORF

State Water Supply Coordinator

State Office of War Training

State Department of Health

State Department of Education

New York Section, American Water Works Association

Municipal Training Institute of New York State

New York State Conference of Mayors

The Association of Towns of the State of New York

Town and County Officers' Training School of the State of New York

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353 Broadway, Albany, New York

March, 1943

PREFACE

The New York State War Council Mutual Aid Water Supply Plan, as formulated by a committee of water works experts appointed jointly by the New York State Conference of Mayors and the State Department of Health, was ordered into operation by Governor's proclamation on October 14, 1941. Later the plan was incorporated in the Laws of 1942 under Chapter 574. This plan was designed to assist local water supply and sanitation authorities in preparing for emergencies, and to facilitate prompt aid from adjoining or neighboring communities to areas affected. The plan should operate effectively to safeguard or restore water service promptly in the event of either war-time emergencies or peace-time catastrophes, such as fires, flood, drought and hurricanes.

In administering such a mutual aid water supply plan, it was natural that the State should turn for assistance to its Division of Sanitation in the State Health Department. On October 14, 1941, Earl Devendorf, Associate Director of the Division of Sanitation, State Health Department, was appointed State Water Supply Coordinator and was requested to engage with his colleagues in the State and local governments in organizing and operating the Mutual Aid Water Supply Plan in New York State.

The Sanitation and Water Works Manual, prepared jointly by the New York State War Council's Office of War Training and the State Water Supply Coordinator, shows the tremendous strides which have been made in preparing for any water or sanitation emergency in New York State.

An integral part of any such plan is the training of those who are to carry it into effect. This Manual contains information on training procedures and courses given to regular forces and to citizens who have volunteered to augment them for emergency sanitation and water works duties.

New York's State and local Public Health and Works agencies are to be congratulated on the job they have done in preparation for safe-

guarding the lives of our people. The soundness of the Mutual Aid Water Supply Plan, for example, was dramatically demonstrated by the speed and effectiveness with which the plan was operated during the Olean flood of July, 1942.

This Manual will be valuable to all agencies dealing with emergency sanitation and water works problems. It is gratifying that many other states are now using the contents of the Manual in the solution of similar problems, as a result of critical evaluations of its contents in professional journals.

ALBERT H. HALL
Director, Office of War Training
New York State War Council

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Lesson V was prepared by C. R. Cox, *Chief, Bureau of Water Supply Control, State Department of Health*

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FOREWORD

The State Coordinator of the Mutual Aid Water Supply Plan, Earl Devendorf, requested the Bureau of Public Service Training of the State Education Department, in April 1942, to assist in the preparation and administration of an emergency water and sanitation auxiliary training program for New York State.

Following a preliminary discussion to establish the general procedure and content of such a program, other training agencies in the state were also requested to aid in this important training activity. These agencies included the Town and County Officers Training School of the State of New York, the Municipal Training Institute of New York State and the New York State Section of the American Waterworks Association.

It was realized at the outset that such training must be decentralized. Therefore, five Regional Schools were held for waterworks and sanitation officials responsible for the organization and training of water main emergency repair crews and other auxiliary waterworks and sanitation personnel.

The schools had two major objectives. First, they were designed to indicate to those who are teaching local water and sanitation auxiliaries approved teaching methods in clear and simple form. A training film, produced by the Signal Corps of the United States Army, which deals exclusively with instructional techniques, was used to demonstrate how instructional material could be presented most effectively.

The second objective of the schools was to demonstrate how to present the thirteen standard classroom and five standard field lessons. This second phase of the schools presented not only teaching methods, but also lesson content. These standard lessons, in complete reference text form, were distributed for local use to the 600 key water and sanitation officials who attended the regional schools.

The Office of War Training of the New York State War Council was established on June 15, 1942. This office was charged with the central direction and guidance of all public employee and civilian war training, except training for war industries, throughout the State. The State War Council requested Albert H. Hall, Chief of the Bureau of Public Service Training of the State Education Department, to direct the new office. Mr. Hall was also designated subse-

quently by the Regents of the University of the State of New York as Director of Public Employee and Civilian War Training of the State Education Department.

Following the establishment of the Office of War Training, home study outlines were prepared from each standard lesson in the emergency water and sanitation auxiliary training course. These outlines constituted complete and concise basic notes on each of the standard lessons. They were distributed to each local official conducting training classes in quantities sufficient to make a copy available to every member of his class. An instructor-training manual, containing suggestions on the organization and presentation of instructional material was also sent to local officials responsible for teaching auxiliaries.

About 2000 water and sanitation auxiliaries have been trained to date. More auxiliaries are now in training.

The Office of War Training, at the request of the State Water Supply Coordinator, has acquired a number of instructional films, including the teacher training film referred to previously, correlated closely with the lesson reference texts of the water and sanitation auxiliary training program. The office has also produced a training film in cooperation with the film units of the State Departments of Conservation and Health.

All of the training procedures and materials developed in the program are included in this Manual. The Manual is thus a useful reference text.

One of the most gratifying phases of this war training effort is the fact that it possesses residual values which will be of great assistance in the peace-time operation of water and sanitation systems.

Lewis A. Wilson
Deputy Commissioner
New York State Education Department

Albany, New York
March 1, 1943

INTRODUCTION

PURPOSE OF THIS MANUAL

War has produced the urgent necessity for specific planning and organization of available resources to meet the problems of possible disruption of the services of water supply, milk supply, and sewerage in local municipalities. Since December 7, 1941, most states have developed comprehensive programs designed to provide guidance and direction for local officials in their efforts to establish proper protection and assurance of continued functioning of these vital services under emergency conditions of any kind.

In respect to preparation of local water departments for wartime operations and to meet the exigencies of possible emergencies arising either as a result of enemy attack or natural catastrophes, New York State has been a pioneer. Its comprehensive Mutual Aid Plan for Water Service, placed in operation in October 1941 and expanded since that time, has served as a pattern for the development of similar programs in many other states. United States Office of Civilian Defense bulletin No. 3030 entitled, "Protection and Maintenance of Public Water Supplies under War Conditions," and issued in September, 1942, recommends a Mutual Aid Plan for adoption by all states, the general structure or pattern of which is substantially the same as the plan now in effective operation in New York State.

The remarkable progress made toward achievement of the specific objectives of the Mutual Aid Plan for Water Service has been due to the wholehearted cooperation of local water authorities and their desire to make the maximum possible contribution to the war effort, and to the loyal and enthusiastic services of Zone and Assistant Zone Water Coordinators in guiding and coordinating the work in the field along predetermined lines in accord with well formulated plans, policies, and procedures. More than ever before, through the concept of mutual aid, local water and health officials and others whose interests lie in the field of water supply have been welded into a common fraternity, anxious to make needed sacrifices and whatever contributions they can make to the winning of the war. The benefits derived from participation in such a program are certain to continue long after the war is over.

Mutual Aid Plan for Water, Milk and Sewer Service.

Development of a Mutual Aid Plan for Milk Service and a Mutual Aid Plan for Sewer Service followed the development and placing in operation of the Mutual Aid Plan for Water Service. The experience gained in operation of the Water Supply Plan proved of great assistance in getting the emergency milk service and sewer service programs under way. The general aspects of these latter programs are discussed in Chapters VII and VIII of Part I of this volume. In principles and organization, the three plans are essentially the same. Such variations as exist are governed by considerations of the particular requirements of the specific services. An understanding of the details of the Mutual Aid Plan for Water Service will be helpful in understanding the organization and mechanics of operation of both the Mutual Aid Plan for Milk Service and the Mutual Aid Plan for Sewer Service. This is recommended to milk and sewer officials, since the contents of this volume deal largely with the preparation of water departments to meet the problems of water supply which are likely to arise as a result of catastrophe or extreme emergency.

Sanitation Services.

Since inauguration of the Mutual Aid Plan for Water Service, many memoranda, bulletins and other mimeographed circulars of information have been issued by the State Water Supply Coordinator to local water authorities and Zone and Assistant Zone Water Coordinators, to provide direction and guidance for local officials in operation of the plan. In April of 1942, the sum and substance of all previous informative material issued in relation to the plan was incorporated in a "Manual of Emergency Sanitation Services" and widely distributed. With necessary revisions to bring it up to date and except for omission of certain confidential information contained in the original, it is reprinted herein in its entirety as Part I.

Water Main Emergency Repair Crews.

One of the primary objectives of the Mutual Aid Plan for Water Service has been to secure within each municipality of the State an adequate number of trained water works auxiliaries, who in the event of a serious "incident" will shut off water main breaks, repair broken mains, establish an emergency door-to-door water delivery service, or operate emergency pumping stations and sew-

age treatment plants. To give impetus and direction to efforts toward this important and urgent objective, and in cooperation with the State Office of War Training, there was prepared Water Series Bulletin No. 1 entitled "Organization and Training of Water Main Emergency Repair Crews and Auxiliary Personnel Assigned to Emergency Water Service Duties," and widely distributed. This bulletin, which outlines in detail the procedures for the recruitment of volunteer auxiliary personnel, the qualifications of such personnel and the course of training to be given to such auxiliaries, is reprinted herein with minor revisions, as Part II.

Emergency Water Service Training.

Following the release of Water Series Bulletin No. 1, there were organized Regional Emergency Water Service Training Schools at five locations in the State. These were conducted for the purpose of:

1) Explaining thoroughly the training program for auxiliaries to local water and sewer officials.
2) To explain to local water officials the details of the course of instruction to be given to water works auxiliaries.
3) To give local water and sewer superintendents, upon whom the main burdens of training are imposed, instruction in teaching technics.

To achieve these purposes, there were obtained the active assistance and cooperation of the State Office of War Training, the State Education Department, the Municipal Training Institute, the Mayors' Conference, the Association of Towns, the American Water Works Association, the National Board of Fire Underwriters, the New York State Fire Insurance Rating Organization, and the superintendents of many public water supplies. The course of instruction as outlined in Bulletin No. 1 was amplified to include complete lesson material upon each subject of the course, prepared in each instance by outstanding experts. This material, originally mimeographed as separate lectures and lesson sheets, was presented at the Regional Emergency Water Service Training Schools to local water officials for their use as guides in giving instructions on the prescribed lessons of the course to their own auxiliaries. All of this original material is reprinted herein as Part III.

Following the Regional Emergency Water Service Training Schools, many local courses, either on a county-wide or municipal

basis, have been organized for the training of water works auxiliaries in the four prescribed classes for emergency water service duties. These courses will be continued until the training program is completed for the State as a whole. Ultimately about 4000 volunteer auxiliaries will have completed the instruction which is being given in a uniform manner throughout the State and according to the prescribed syllabus of this course. In all these courses the lectures and lesson material reprinted herein in Part III are being used as guides for instructors in presentation of the instruction to the Auxiliaries.

The experience thus far acquired has proven that the course of instruction, as recommended here, is sound and that Auxiliaries who satisfactorily complete the same are actually competent to perform their duties in any emergency organization of a water department.

There has been such a wide demand for copies of the complete lectures and lesson material for distribution to the Water Works Auxiliaries themselves for purposes of reference and supplemental reading that it seemed wise to compile the same in one volume along with reprints of the Emergency Sanitation Manual and Water Series Bulletin No. 1. This has been made possible through the assistance of Mr. Albert H. Hall, Director of the Office of War Training of the New York State War Council, without whose assistance and the cooperation of his staff, the great success already achieved in the training of Water Works Auxiliaries would not have been possible.

It is hoped that all Water Works officials and Water Works Auxiliaries will find in this volume the detailed instructions, information, and suggested directions which they will need to give complete cooperation, and participate effectively in the New York State Mutual Aid Plan for Water Service, to the end that each in his own community will be worthy of the trust and confidence reposed in him as a public servant responsible for the most vital of all community services.

Imbued with the spirit of self-sacrifice and cooperativeness, desirous of promoting the democratic principles of mutual assistance to the maximum degree possible, and devoted to the emergency tasks that confront them in wartime, the great fraternity of Water Works officials and employees may be relied upon with confidence, for both public health and fire protection, to *"Keep the water flowing."*

State Health Department
Albany, New York
March 1, 1943

Earl Devendorf
State Water Supply Coordinator

PART I

ORGANIZATION AND OPERATION OF EMERGENCY SANITATION SERVICES

Purpose of Part I.

Part I is for the instruction and use of local health, water, sewer and milk officials and for the information of local Directors of Civilian Protection.

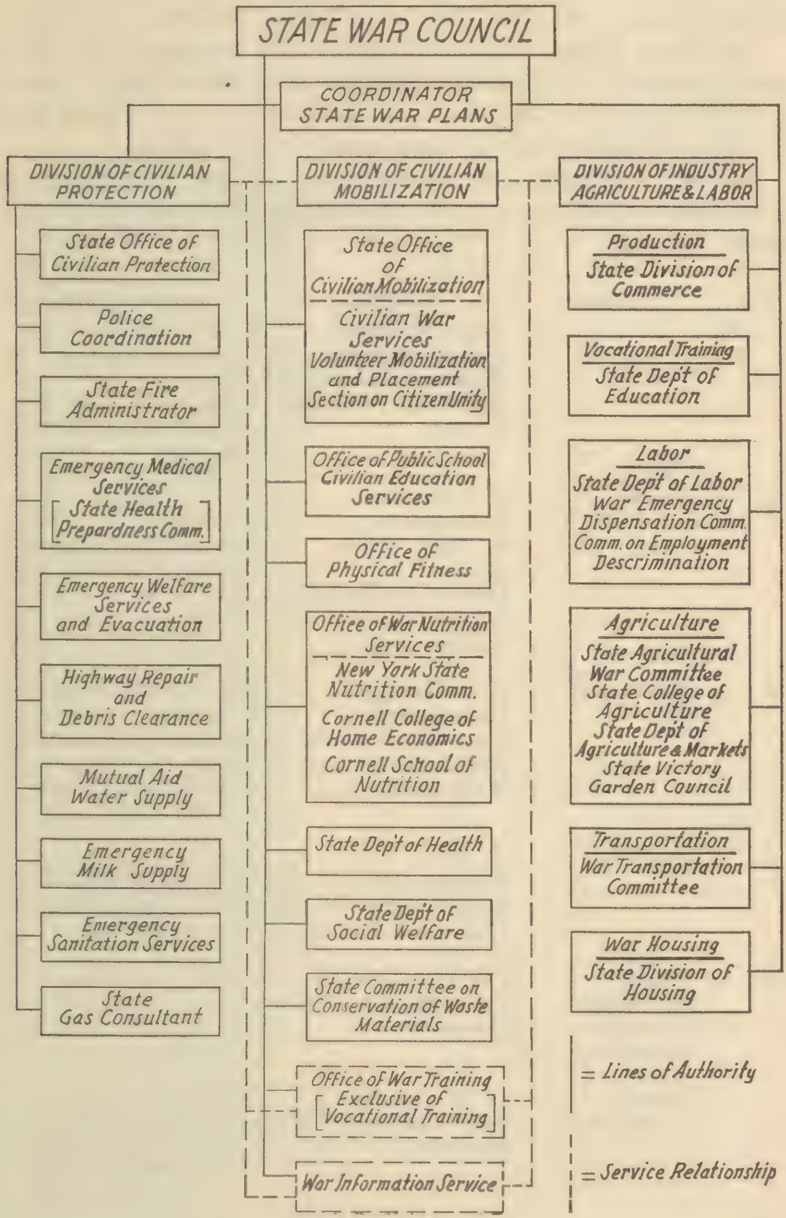
The war emergency has produced the necessity for the Mutual Aid Plan for Water Service and similar plans to facilitate preparation for and organization of available resources to meet the problems of catastrophes. Part I sets forth the delimitation of the fields of effort and the steps which should be taken to provide for the necessary organization, training, records, responsibilities and duties of those who are engaged in maintaining the vital services of water supply, milk supply and sewerage in local municipalities.

Specific planning for emergencies in a realistic manner without hysteria should be the order of the day. To a large extent, well conceived and developed plans to meet emergency situations will reduce to a minimum the possibilities of serious catastrophes. Thorough organization of the regular forces responsible for water supply, milk supply and sewerage, supplemented by trained auxiliary personnel, are essential to cope with the problems of providing for prompt restoration of vital services when these are disrupted as a result of bombing attacks, fifth column attacks, or sabotage. Such organization is necessary to avoid the great confusion that will attend disaster situations when local authorities are unprepared to meet them.

Part I prescribes not only the specific plans and preparatory steps which should be taken in advance of any emergencies, but the detailed emergency organizations which should be developed as parts of the civilian protective services of the local communities which are necessary to efficient maintenance or prompt restoration of the three vital services mentioned. The organization of the regular forces of water and sewer departments for emergency services and their supplementation by trained auxiliary personnel are discussed in considerable detail.

Part I also gives technical advice for guidance of local authorities in meeting the special problems involved in the preparation for and handling of serious emergencies. It thus should serve local water, sewer, and milk officials and local Directors of Civilian Protection as a reference for indications of both the technical solution of various emergency problems and the procedures by which these vital services are integrated with the civilian protection plans of each community.

NEW YORK STATE WAR COUNCIL
ORGANIZATION CHART



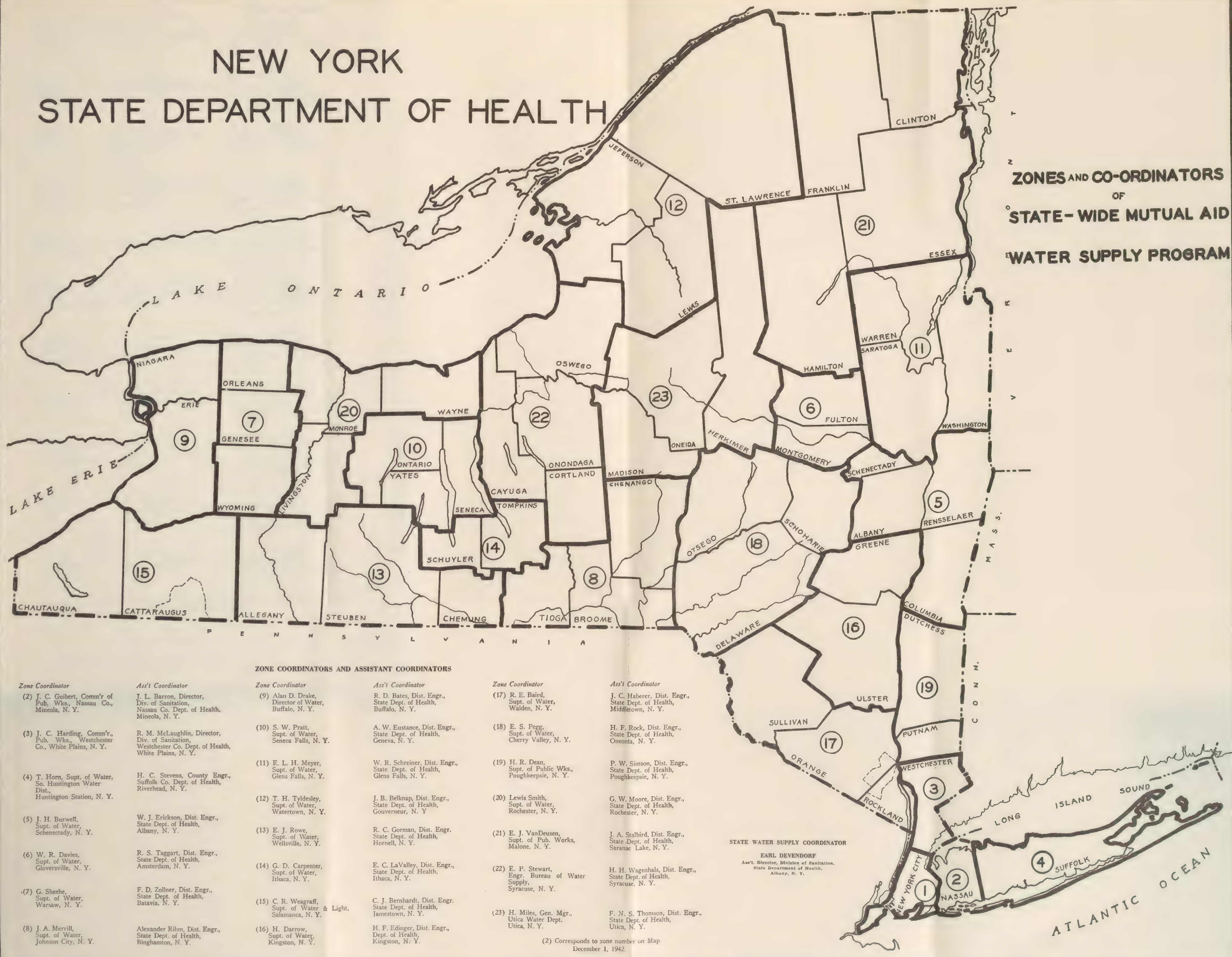
Chapter I. Administrative Organization of Mutual Aid Plan For Water Service

For purposes of administration and control the State is divided into 22 water service zones (New York City, Zone 1, is not included in the provisions of the New York State Mutual Aid Plan).

The State Water Supply Coordinator, as directing head of the plan, is assisted by a Zone and Assistant Zone Water Supply Coordinator in each of the 22 zones. All coordinators serve without additional compensation and are appointed by the Governor.

The 22 established water service zones of New York State, and the names and addresses of the Coordinators and Assistant Coordinators follow:

Zone	*Counties*	*Coordinator*	*Assistant Coordinator*
STATE	....	EARL DEVENDORF, *Assistant Director*, Division of Sanitation State Dept. of Health, Albany	A. F. DAPPERT, Principal Sanitary Engineer, Division of Sanitation State Dept. of Health, Albany
2.....	Nassau	J. C. GUIBERT, Commissioner, W. FRED WELSCH, Assistant, Dept. of Public Works, Nassau County Mineola	J. L. BARRON, Director, Division of Sanitation Nassau County Dept. of Health, Mineola
3.....	Westchester	J. C. HARDING, Commissioner, Dept. Public Works, Westchester County White Plains	R. M. MCLAUGHLIN, Director, Division of Sanitation Dept. of Health, Westchester County White Plains
4.....	Suffolk........	T. HORN, Superintendent of Water, So. Huntington W. D., Huntington Station	W. H. LARKIN, District Engineer, State Dept. of Health, New York City
5.....	Albany Columbia Rensselaer Schenectady	JOHN BURWELL, Superintendent of Water, Schenectady	W. J. ERICKSON, District Engineer, State Dept. of Health. Albany
6.....	Fulton Montgomery	W. R. DAVIES, Superintendent of Water, Gloversville	R. S. TAGGART, District Engineer, State Dept. of Health, Amsterdam



ZONE COORDINATORS AND ASSISTANT COORDINATORS

Zone Coordinator	*Ass't Coordinator*
(2) J. C. Guibert, Comm'r of Pub. Wks., Nassau Co., Mineola, N. Y.	J. L. Barron, Director, Div. of Sanitation, Nassau Co. Dept. of Health, Mineola, N. Y.
(3) J. C. Harding, Comm'r., Pub. Wks., Westchester Co., White Plains, N. Y.	R. M. McLaughlin, Director, Div. of Sanitation, Westchester Co. Dept. of Health, White Plains, N. Y.
(4) T. Horn, Supt. of Water, So. Huntington Water Dist., Huntington Station, N. Y.	H. C. Stevens, County Engr., Suffolk Co. Dept. of Health, Riverhead, N. Y.
(5) J. H. Burwell, Supt. of Water, Schenectady, N. Y.	W. J. Erickson, Dist. Engr., State Dept. of Health, Albany, N. Y.
(6) W. R. Davies, Supt. of Water, Gloversville, N. Y.	R. S. Taggart, Dist. Engr., State Dept. of Health, Amsterdam, N. Y.
(7) G. Sheehe, Supt. of Water, Warsaw, N. Y.	F. D. Zollner, Dist. Engr., State Dept. of Health, Batavia, N. Y.
(8) J. A. Merrill, Supt. of Water, Johnson City, N. Y.	Alexander Rihm, Dist. Engr., State Dept. of Health, Binghamton, N. Y.
(9) Alan D. Drake, Director of Water, Buffalo, N. Y.	R. D. Bates, Dist. Engr., State Dept. of Health, Buffalo, N. Y.
(10) S. W. Pratt, Supt. of Water, Seneca Falls, N. Y.	A. W. Eustance, Dist. Engr., State Dept. of Health, Geneva, N. Y.
(11) E. L. H. Meyer, Supt. of Water, Glens Falls, N. Y.	W. R. Schreiner, Dist. Engr., State Dept. of Health, Glens Falls, N. Y.
(12) T. H. Tyldesley, Supt. of Water, Watertown, N. Y.	J. B. Belknap, Dist. Engr., State Dept. of Health, Gouverneur, N. Y
(13) E. J. Rowe, Supt. of Water, Wellsville, N. Y.	R. C. Gorman, Dist. Engr. State Dept. of Health, Hornell, N. Y.
(14) G. D. Carpenter, Supt. of Water, Ithaca, N. Y.	E. C. LaValley, Dist. Engr., State Dept. of Health. Ithaca, N. Y.
(15) C. R. Weagraff, Supt. of Water & Light, Salamanca, N. Y.	C. J. Bernhardt, Dist. Engr. State Dept. of Health, Jamestown, N. Y.
(16) H. Darrow, Supt. of Water, Kingston, N. Y.	H. F. Edinger, Dist. Engr., Dept. of Health, Kingston, N. Y.
(17) R. E. Baird, Supt. of Water, Walden, N. Y.	J. C. Haberer, Dist. Engr., State Dept. of Health, Middletown, N. Y.
(18) E. S. Pegg, Supt. of Water, Cherry Valley, N. Y.	H. F. Rock, Dist. Engr., State Dept. of Health, Oneonta, N. Y.
(19) H. R. Dean, Supt. of Public Wks., Poughkeepsie, N. Y.	P. W. Simson, Dist. Engr., State Dept. of Health, Poughkeepsie, N. Y.
(20) Lewis Smith, Supt. of Water, Rochester, N. Y.	G. W. Moore, Dist. Engr., State Dept. of Health, Rochester, N. Y.
(21) E. J. VanDeusen, Supt. of Pub. Works, Malone, N. Y.	J. A. Stalbird, Dist. Engr., State Dept. of Health, Saranac Lake, N. Y.
(22) E. P. Stewart, Engr. Bureau of Water Supply, Syracuse, N. Y.	H. H. Wagenhals, Dist. Engr., State Dept. of Health, Syracuse, N. Y.
(23) H. Miles, Gen. Mgr., Utica Water Dept. Utica, N. Y.	F. N. S. Thomson, Dist. Engr., State Dept. of Health, Utica, N. Y.

(2) Corresponds to zone number on Map
December 1, 1942.

STATE WATER SUPPLY COORDINATOR

EARL DEVENDORF
Ass't. Director, Division of Sanitation,
State Department of Health,
Albany, N. Y.

Zone	*Counties*	*Coordinator*	*Assistant Coordinator*
7.....	Genesee Orleans Wyoming	G. SHEEHE, Superintendent of Water, Warsaw	F. D. ZOLLNER, District Engineer, State Dept. of Health, Batavia
8.....	Broome Chenango Tioga	J. A. MERRILL, Superintendent of Water, Johnson City	ALEXANDER RIHM, District Engineer, State Dept. of Health, Binghamton
9.....	Erie Niagara	ALAN DRAKE, Director, Dept. of Water, Buffalo	R. D. BATES, District Engineer, State Dept. of Health, Buffalo
10.....	Ontario Seneca Yates	S. W. PRATT, Superintendent of Water, Seneca Falls	A. W. EUSTANCE, District Engineer, State Dept. of Health, Geneva
11.....	Saratoga Warren Washington	E. L. H. MEYER, Superintendent of Water, Glens Falls	W. R. SCHREINER, District Engineer, State Dept. of Health, Glens Falls
12.....	Jefferson Lewis St. Lawrence	T. H. TYLDESLEY, Superintendent of Water, Watertown	J. B. BELKNAP, District Engineer, State Dept. of Health, Gouverneur
13.....	Allegany Chemung Steuben	E. J. ROWE, Superintendent of Water, Wellsville	R. C. GORMAN, District Engineer, State Dept. of Health, Hornell
14.....	Schuyler Tompkins	G. D. CARPENTER, Superintendent of Water, Ithaca	E. C. LA VALLEY, District Engineer, State Dept. of Health, Ithaca
15.....	Cattaraugus Chautauqua	C. R. WEAGRAFF, Supt. of Water andLight, Salamanca	C. J. BERNHARDT, District Engineer, State Dept. of Health, Jamestown
16.....	Greene Ulster	H. DARROW, Superintendent of Water, Kingston	H. F. EDINGER, District Engineer, State Dept. of Health, Kingston
17.....	Orange Rockland Sullivan	R. E. BAIRD, Superintendent of Water, Walden	J. C. HABERER, District Engineer, State Dept. of Health, Middletown

Zone	Counties	Coordinator	Assistant Coordinator
18.....	Delaware Otsego Schoharie	E. S. Pegg, Superintendent of Water, Cherry Valley	H. F. Rock, District Engineer, State Dept. of Health, Oneonta
19.....	Dutchess Putnam	H. R. Dean, Superintendent of Public Works, Poughkeepsie	P. W. Simson, District Engineer, State Dept. of Health, Poughkeepsie
20.....	Livingston Monroe Wayne	Lewis Smith, Superintendent of Water, Rochester	G. W. Moore, District Engineer, State Dept. of Health, Rochester
21.....	Clinton Essex Franklin Hamilton	E. J. Van Deusen, Supt. of Public Works, Malone	J. A. Stalbird, District Engineer, State Dept. of Health, Saranac Lake
22.....	Cayuga Cortland Onondaga Oswego	E. P. Stewart, Engineer, Bureau Water Supply, Syracuse	H. H. Wagenhals, District Engineer, State Dept. of Health, Syracuse
23.....	Herkimer Madison Oneida	H. Miles, General Manager, Utica Water Department, Utica	F. N. S. Thomson, District Engineer, State Dept. of Health, Utica

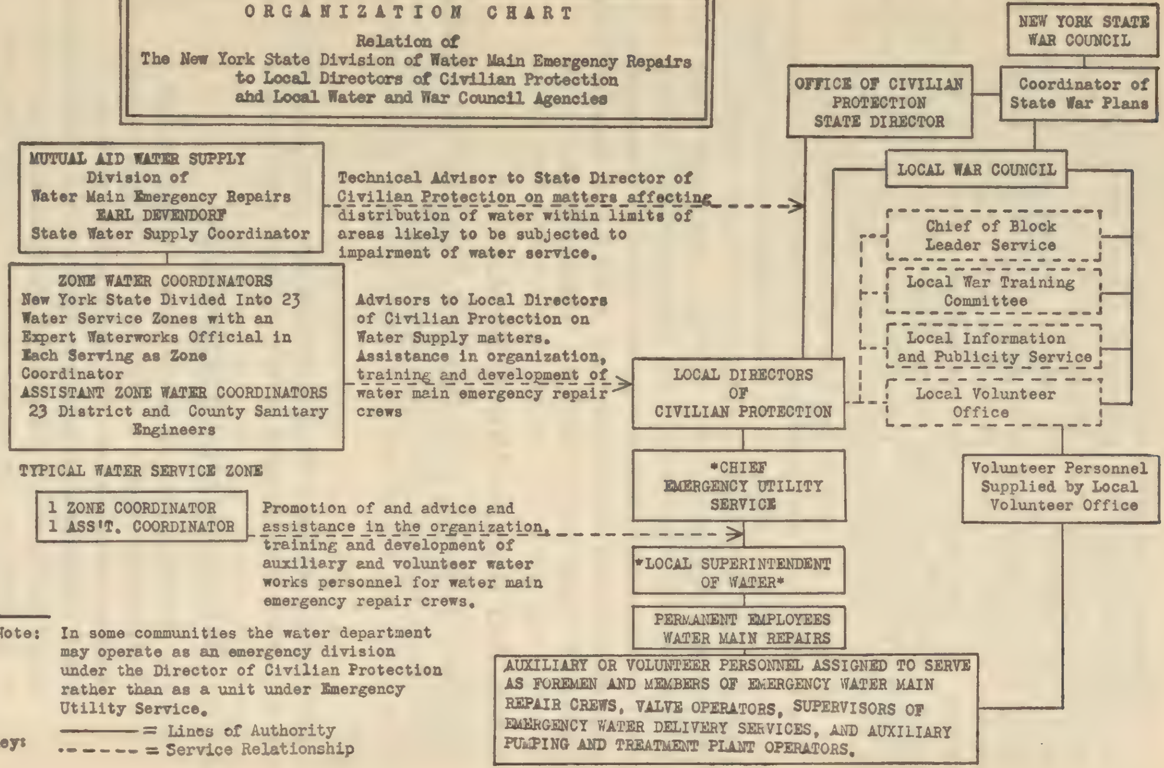
In the field of general preparations, which embrace the first ten stated objectives as given in Chapter II, the State and Zone Water Supply Coordinators work directly and very closely with the local water officials but keep the State and local Directors of Civilian Protection advised generally as to the needs and progress of the work under the plan.

In the field of civilian protection, however, the entire administrative organization of the Mutual Aid Plan constitutes a Division of Water Main Emergency Repairs in the State Office of Civilian Protection. The State Water Supply Coordinator is technical adviser to the State Director of Civilian Protection in relation to all water supply matters, and Zone Coordinators serve in a similar way as technical advisors to local Directors of Civilian Protection, and to local water officials.

The accompanying chart indicates the organization of the Division of Water Main Emergency Repairs and its relationship to civilian protection officials at both the State and local levels.

ORGANIZATION CHART

Relation of The New York State Division of Water Main Emergency Repairs to Local Directors of Civilian Protection and Local Water and War Council Agencies



*Note: In some communities the water department may operate as an emergency division under the Director of Civilian Protection rather than as a unit under Emergency Utility Service.

Key: ——— = Lines of Authority
- - - - = Service Relationship

Chapter II. General Aspects of the Mutual Aid Plan for Water Service

Maintenance of an ample and safe supply of water is required for the public health and fire protection of any community. In any catastrophe the public water supply is likely to be impaired in both quality and quantity. In the case of bombing attacks numerous breaks in water mains may occur, resulting in complete failure of the supply. Without adequate preparation and organization for emergencies, the local water authorities will be unable to make needed repairs promptly and attend to the many other emergency water problems which may arise. Delays in making repairs and restoring water service may easily result in a major catastrophe when otherwise the conditions could be reduced to bearable proportions.

The organization and preparation for water supply emergencies involves a variety of steps, all of which should be taken as speedily as possible and long before an emergency occurs. All these steps, including the organization of water main emergency repair crews and the operation of the local water department as a unit for emergency service within the local civilian protection organization, are encompassed by the New York State Mutual Aid Plan for Water Service, the objectives of which are outlined below.

Mutual Aid Plan for Water Service.

Purpose. To prepare the State and all of its municipal and other political subdivisions to effect and maintain safe and adequate water service under any severe emergency conditions produced by enemy action.

Objectives. The specific objectives of the plan as applying to each local water authority are briefly indicated as follows:

In the Field of General Preparations.

1 The interconnection of public water supply systems.

2 The interconnection of public water supply systems with *approved* industrial or other water supply systems.
(Such interconnections if exploited to the fullest possible extent make possible a continued supply of water in the event of the failure of one supply, by drawing upon the other.)

3 The preparation and maintenance of accurate maps of distributing systems or revision of existing maps to an up-to-date status.

4 The preparation and maintenance of accurate records (book or otherwise) of the location of valves and other vital parts of the systems.

5 The frequent testing of valves and fire hydrants to assure that these are in proper working condition at all times. (The maintenance of accurate records and assurance of proper working condition of valves and hydrants are necessary to prevent costly delays in meeting the exigencies in an actual emergency.)

6 Collaboration with local fire officials in regard to:

a Surveys and preparation for use of all possible emergency sources of water supply which may require pumping into the system during an emergency.

b The characteristics of valves and fire hydrants and the need for hydrant adapters.

c Surveys of distribution systems for defects and weaknesses and development of plans for their correction, together with reinforcement of systems to the maximum degree possible.

7 Collaboration with local power and other utility officials in regard to conditions that may affect operation of the water supply in an emergency and the measures to be taken to assure ability of the water system to function in event of the failure of other utility services.

8 Collaboration with local fire and war industry officials in regard to deficiencies in water service and fire protection furnished to war industries and cooperation in correcting such deficiencies.

9 The thorough study and consideration of the needs for protection against possible water works sabotage or fifth column attacks and the adoption of such measures as are reasonable and consistent with the needs of each particular community.

10 The preparation of a detailed inventory of water works personnel, equipment, materials and supplies and the submission of such data to the Zone Water Supply Coordinator. (The filing of such inventories will enable needed assistance to be promptly rendered to any local water authority when confronted with a serious emergency.)

In the Field of Civilian Protection:

1 Collaboration with local directors of civilian protection for the purpose of integrating the civilian protection features of the Mutual Aid Plan with the plans of local civilian protection.

2 Technical advisory assistance on all matters related to water supply to the State Director of Civilian Protection and local Directors of Civilian Protection.

3 The organization, training, equipment and operation of water main emergency repair crews and other auxiliary or reserve water works personnel, to function through the local water superintendent under the local Director of Civilian Protection.

Chapter III. Operation of Plan in the Field of General Preparations

General. Zone and Assistant Zone Coordinators acting under general direction of the State Water Supply Coordinator work directly among local water offiicials toward the first ten specific objectives of the Mutual Aid Plan enumerated in Chapter II. The State and local Directors of Civilian Protection are kept advised as to progress of the work, and as required, may be called upon to lend assistance in regard to many particular problems. The efforts of local water authorities in the field of general preparation for emergencies should be coordinated as much as possible with all other local civilian protection plans through the water service representative of the local Director of Civilian Protection, and with the plans of other local Directors in each zone by the Zone Water Coordinator.

Channel of Communications. Matters related to general preparations will be channeled by the local water official direct to the Zone Water Supply Coordinator and by the Zone Coordinator direct to the State Water Supply Coordinator if the matter is one which requires the latter's attention.

General Preparations for Water Supply Emergencies.

The essential steps which local water officials should take in relation to the several objectives of the Mutual Aid Plan are discussed below:

Interconnections with Adjoining Public Water Supplies. These are needed wherever it is feasible to construct them, so that in event of failure of one supply full or partial water service may be maintained by drawing upon the other.

Local water authorities should consult with adjoining water authorities, give serious consideration to the installation of such interconnections, appraise them from the standpoint of their value to both communities, prepare plans, and agree on the joint arrangement for their use.

Preliminary plans should be prepared in quadruplicate and forwarded to the Zone Water Supply Coordinator. The Zone Coordinator will forward a copy to the Board of Fire Underwriters or the New York State Fire Insurance Rating Organization, as the case may be, for review and comments. The Zone Coordinator or the local water officials will furnish two or three copies of final plans to the State Water Supply Coordinator for approval and for distri-

bution to the State Water Power and Control Commission and to the Public Service Commission in cases where such proposed interconnections involve a water company.

Although most interconnections will have to be made at the fringes of systems, and in certain cases under conditions of great variations in differential pressures, the value of such interconnections even under such circumstances should not be underestimated. Under conditions of a severe bombing attack there is likely to be a complete water failure in one community or the other, in which case it may be possible to supply water to limited sections of the stricken community irrespective of what the normal static pressures of the two systems may have been.

Chapter 574 of the Laws of 1942, which gives legal recognition to the Mutual Aid Plan for Water Service, requires the approval of the State Water Supply Coordinator for all such proposed interconnections and the arrangement for division of the cost of their construction. Local officials should become familiar with the provisions of this law, particularly with reference to interconnections and the additional authority conferred upon local municipalities in regard to the financing and construction of interconnections.

Interconnections with Approved Industrial Water Supplies. Interconnections between public and *approved* industrial water supply systems should be installed wherever practicable, so that in event of failure of the municipal supply, full or partial water service to the community can be furnished by the industry. However, in such cases the industrial supply must be of assured safe sanitary quality and the interconnection before it is installed must be approved by the State Department of Health. Cross-connections between municipal supplies and unapproved industrial or other supplies of unsafe or doubtful quality are prohibited by Chapter V of the Sanitary Code. Whenever cross-connections are made between municipal and safe industrial water supplies, the State Department of Health in issuing approval will require local water authorities to maintain supervision and control over the interconnection and over the quality of the water supply of the industry.

Local water authorities are urged to consider such interconnections and collaborate with Zone or Assistant Zone Water Coordinators in regard to their installation.

Records of Distributing Systems, Valve Locations, etc. Maps of distributing systems should be brought up to date and a copy furnished to the Zone Coordinator.

Book Records. Records should be maintained giving accurate "tie-ins" to location of valves and other essential elements on the system so that these may be found in the field without delay in case the need arises. Such records should be maintained at two or more separate locations, should be considered confidential and made available only to authorized persons.

Tests of Valves and Fire Hydrants. Tests should be made with sufficient frequency to assure proper operating conditions at all times.

Collaboration with Local Fire Officials.

a **Emergency Water Supplies.** Each local water authority, with the cooperation of local fire authorities, should make a thorough study of all possible emergency sources of water supply, the utilization of which might be necessary by pumping into the system in the event of an emergency.

Such studies should determine the amount of water available from each emergency source and the pumping and chlorination equipment required in the event of use. So far as possible such equipment and arrangements for chlorination and control over the operations should be provided in advance and be held in readiness for any emergency.

Consult with Zone and Assistant Zone Coordinators as to treatment required for all water pumped into systems from emergency sources. In general, the State Department of Health will require chlorination to produce a residual of not less than 0.5 parts per million after a 15 minute contact period.

In the event it becomes necessary to utilize an emergency source, notify the local health officer as far in advance as possible, so that he in turn may notify the State Department of Health. This is required by Regulation 4 of Chapter V of the Sanitary Code.

b **Valves, Hydrants and Need for Adapters.** These should be ascertained and made a part of the permanent records. Such information should be made available to the local fire authorities, so that they may acquire hydrant adapters if these are needed and so as to avoid damage to valves through wrong manipulation.

c **Surveys of Distribution System Defects and Weaknesses, etc.** These should be made by the local water authorities with the cooperation of local fire authorities. The survey should consider "bottlenecks" or points on the system where flows are restricted, weak points such as stream crossings where pipe failures are likely to occur, surveys for leaks or excess water wastage, etc. So far as possible, grid systems should be without dead ends, each

point on the system should be capable of supply from more than one direction, and the system should be equipped with sufficient valves so that in event of a water failure shut-offs may be limited to small sections.

Present shortage of materials will militate against any substantial improvements to distributing systems, except in case of gross deficiencies in defense connected communities. However, it will be found frequently that minor improvements can be made which will strengthen the system considerably.

The aim should be to reinforce distributing systems to the fullest possible extent. Collaboration with Zone Coordinators and representatives of the New York Fire Insurance Rating Organization will be helpful in this respect.

Collaboration with Local Power and Other Utility Officials, etc. Consult with power and other local utility officials in regard to the problems which are likely to arise from power and other utility failures in an emergency. Where pumping stations rely on only a single source of power, consideration should be given to providing for standby equipment, such as gasoline engines, motor generator sets, etc.

Collaboration with Local Fire and War Industry Officials. There should be consultation with the appropriate officials to assure that problems involving water supply and fire protection furnished to war industries will be given adequate attention.

Protection Against Sabotage and Fifth Column Attacks. This is a matter which should be thoroughly considered by all local water authorities. Obviously the matter is of urgent importance in the larger cities and in defense connected communities. Local water authorities are regarded as being more competent than anyone else to decide upon the measures which should be adopted. In important defense connected communities the commanding officers of military districts, upon requests made through Zone Coordinators, will review plans for protective measures and give advisory assistance in regard to such problems.

Obviously there are some supplies which are of such extreme importance to the national war effort that vulnerable structures and points on the system should be provided with 24 hour guard service. There are others where roving patrols established by local police or with the cooperation of State police can be considered as providing a considerable degree of protection.

J. Edgar Hoover stresses the investigation of the background and loyalty of all employees, and particularly those recently discharged,

as being one of the most important steps to be taken in protecting against sabotage. In this connection, fingerprinting of employees is recommended: City police, county sheriffs and State police are prepared to give fingerprinting service.

Protective illumination of approach areas to important water works structures, fencing and other similar measures should be considered. Generally, technical advice on the desirability of such measures and the details of their application should be secured. Doors to pumping stations, etc., should be kept locked and the keys made available to only a few trusted employees. Where protective illumination is employed, consideration must be given to additional protective measures which may be required under blackout conditions when protective lights are turned off.

Visitors to water works and water works properties should be very much restricted and under rigid control during the war. Employees should be provided with identification cards and required to use them.

Possibilities of sabotage through chemical poisons or bacterial cultures are believed to have been very much over-emphasized but should be considered. These are discussed in a separate chapter of this manual.

In general, common sense and judgment must be used in determining the protective measure to be adopted in any community. The possibilities of sabotage in all of its aspects should be thoroughly considered and such measures adopted as are indicated by the local circumstances and needs.

Each municipality must provide and pay for the protective measures and services it establishes. The State Guard is not available for such purposes.

Possible Fifth Column Attacks. The extent of a fifth column organization in this country has not been made known to the public. The possibility of fifth column attacks on water works, particularly those in important defense connected communities or strategic areas, may be very remote and highly speculative. On the other hand, there may be well developed fifth column plans for attacks on vital public utilities of which no one is aware. Local water officials in strategic communities cannot afford to ignore such possibilities. Therefore, in the important defense connected communities it is important that steps be taken to guard against such an eventuality.

Preparations against possible fifth column attacks on water works should be worked out directly with police officials. Persons to be armed with pistols must obtain pistol permits. Permits are not

required of persons armed with rifles or shotguns. Guards and watchmen may be deputized as special police within municipalities wherein they are employed, or, if employed outside of the municipality they may be deputized as special deputy sheriffs.

Local water authorities should work out all such arrangements for providing arms to employees through the sheriffs or other police officials.

Posting of Water Works Properties. Chapter 821 of the Laws of 1941 authorizes the posting of signs reading "No Entry Without Permission by Order State (War) Council (of Defense)," provided such signs are approved by that agency. In general, the use of such signs is recommended. Requests for approval of such signs should be sent to the State Attorney General, who handles approvals for the State War Council.

On November 30, 1940, Congress amended the Federal Law (Pub. No. 886–76 or Congress Chapter 926–3d Session H.R. 10465) in relation to trespassing as effecting national defense, applying in particular to war industries, premises or utilities used in connection with production of war materials. The law provides a penalty of $10,000 fine or 10 years imprisonment for attempts at sabotage or wilful injury or destruction of war material.

Because of the extent of Army and Navy property and numerous war industries in New York State, this law has rather extensive application.

Local water authorities should determine whether this law applies to their local conditions and act accordingly.

Inventories of Personnel, Equipment, Materials and Supplies. Local water authorities, if they have not done so, should complete a detailed inventory of water works personnel, equipment, materials and supplies and file this with the Zone Coordinator. If an emergency occurs and assistance is needed, the Zone Coordinator should be requested to furnish the personnel, equipment, materials or supplies desired. If the matter is urgent, the Zone Coordinator will arrange for the loan from some other municipalities of such personnel, materials, equipment or supplies as are needed.

Inventory data filed with Zone Coordinators are treated as confidential, and local water authorities will be asked to extend assistance to other municipalities only in time of dire need.

Such inventories should be made to the Zone Coordinator once each year; but at any time, if there is an important or substantial change in the inventory as previously filed, the Zone Coordinator should be notified of such change.

Chapter IV. Operation of Plan in the Field of Civilian Protection

General. Zone and Assistant Zone Water Supply Coordinators, under general direction of the State Water Supply Coordinator, constitute a Division of Water Main Emergency Repairs in the State Office of Civilian Protection, and work in cooperation with State and local civilian protection officials in attaining the objectives enumerated under the field of civilian protection in Chapter II.

No other public utility is so important as water supply. Local water authorities should see to it that they are taken in and recognized as an integral part of the civilian protection organization in their communities, as outlined in this manual. Arrangements for proper liaison between control centers and local water authorities should be worked out through the local Directors of Civilian Protection so that the water authorities will be notified promptly of air raid alarms or other incidents that may affect or endanger the water supply. Plans should be worked out through the local Director of Civilian Protection for utilization of air raid wardens as reporters of broken water mains or other water incidents, but air raid wardens should not be permitted to tamper with valves or fire hydrants or other elements of the distribution system. These duties should be reserved for regular employees of the water department or auxiliary personnel thoroughly trained by the water authorities for such emergency duties.

Inasmuch as the bombing of water mains is very likely to be accompanied by serious damage to nearby sewers, gas mains, electrical conduits, etc., arrangements should be made with Department of Public Works and the representatives of utilities for mutual assistance and planned team work in making repairs to the damaged structures.

The Division of Water Main Emergency Repairs.

In the field of *civilian protection* the Mutual Aid Plan administrative organization constitutes a Division of Water Main Emergency Repairs under the State Director of Civilian Protection. On the chart included herein the organization of this division and its relationship to local Directors of Civilian Protection and local water officials is indicated.

The State Director of Civilian Protection in the field of civilian protection is charged with general direction and coordination of all civilian protection activities between two or more local offices of civilian protection and is thus responsible for the disposition of

civilian protection personnel between two or more offices of civilian protection and their direction in the field.

The responsibilities and duties of the State Director of Civilian Protection in relation to the Mutual Aid Plan for Water Service involving two or more local offices of civilian protection, are discharged through the State Water Coordinator.

The State Water Supply Coordinator is technical adviser to the State Director of Civilian Protection on all matters related to water service and particularly those which affect distribution of water within the limits of areas which are likely to be subjected to impairment of water service. The Zone and Assistant Coordinators serve in a similar capacity as technical advisors to the local Directors of Civilian Protection and local water officials.

The local water official or person in responsible charge of the community's water supply is the technical adviser and responsible directive authority of the local Director of Civilian Protection in relation to all emergency water service matters. The local water official or superintendent will utilize the regular water department employees to perform and direct the functions of repair and maintenance. With reference to emergency repairs of water mains, he will, on behalf of the local Director of Civilian Protection have auxiliary or volunteer personnel enrolled and directed to this protective service by the civilian mobilization representative. Standards for such enrollees as formulated by the State Water Supply Coordinator and issued to the State Director of Civilian Mobilization by the State Director of Civilian Protection are given in a subsequent section of this manual. The local Director of Civilian Protection will arrange for appropriate insignia approved by the State Director of Civilian Protection for volunteer personnel assigned to emergency water service duties. Issuance of such insignia is necessary to enable auxiliary workers to reach their designated stations during air raid alarms or actual emergencies.

It is the duty of the local water superintendent to formulate plans for the organization and training of auxiliary or volunteer personnel to be utilized as foremen or members of water main emergency repair crews or in other emergency capacities, and furnish copies thereof to Zone and Assistant Zone Water Supply Coordinators. It is also a responsibility of the local water superintendent to train the auxiliary or volunteer personnel in the duties and technical work encompassed by the outline of a course of instruction prepared by the State Water Supply Coordinator in conjunction with the Office of War Training of the State War Council. An outline of this course of instruction,

along with recommendations as to the number of water main emergency repair crews which should be organized, developed and trained, is given in Chapter V of this Manual.

In the larger communities all emergency utility services may be grouped under the general command of one individual member of the staff of the local Director of Civilian Protection, in which case the local water superintendent will be his technical adviser and person responsible for preparation and execution of plans, organization, training and assignment. In smaller communities and in some other instances the local water superintendent may be appointed to serve as a member of the staff of the local Director of Civilian Protection.

Responsibilities of Local Water Authorities.

Local water officials are clearly responsible for the management and operation of public water supplies. These responsibilities are inherent and cannot be shifted from the water officials to anyone else. If a catastrophe occurs, it will be the local water officials and no one else who will have to take the blame for shortcomings of any kind, irrespective of the attempts which may have been made to delegate responsibilities to others. These responsibilities, therefore, should be clearly recognized by local Directors of Civilian Protection and freely assumed by water officials.

In relation to the whole field of protective services as applied to water supply operation and maintenance, emergency repairs, etc., the local water officials have the sole responsibilities and must make the decisions on all matters related to the supply of water in the community. They must assume the responsibilities for the work of all regular and auxiliary personnel assigned to emergency water service duties and must suffer no interference from other elements of the local civilian protection organization on matters that clearly fall within the scope of their responsibilities.

Clear recognition of these principles by both local Directors of Civilian Protection and local water authorities will contribute to the most efficient functioning of the water department as a unit in the local civilian protection organization and to the kind of relationships which must be established to assure teamwork and fullest cooperation.

Control Center Liaison with Water Department.

In event of a serious bombing, extent of the disruption of water service will be the primary factor governing the degree of the catastrophe. If water fails, all else fails. Without water, fire depart-

ments will be unable to control fires and the catastrophe will run its natural course. The difference of a few minutes in closing valves to stop the loss of water at a break may mean all the difference in the world in diminishing the extent of the catastrophe.

It is therefore of utmost importance that adequate arrangements be set up in the control or report center of each community, so that water officials will receive immediate reports of air raid alert signals and prompt reports of water incidents relayed to the control center by air raid wardens. It is important that water officials be notified of air raid warning signals, etc., as promptly as such warnings are made to fire officials. The water department must be notified of all advance air raid alert signals as well as "red" signals, so that it can place all of its personnel in readiness for instant action in case an actual air raid occurs.

A representative of the water department should be in attendance at the control center at all times, responsible for the relaying of messages to the water official. In the control center there should be complete plans of all the water mains in the area (skeleton plans are good enough), with sizes and valve positions prominently marked, together with "key" industries, charts and names, addresses and telephone numbers of all personnel likely to be needed in any emergency, together with similar data concerning the key men of other adjoining water authorities and their control services. The key industries should be informed if any incident occurs affecting their supplies. Standby messenger service should be available in case telephone lines are out of order.

Air raid wardens, in making reports of water incidents, should state the exact position of the incident, the time of origin, whether inside or outside of premises, other services affected, whether the break appears large or small, obstructions and such other helpful information as it is possible for them to obtain quickly. These reports should be made to the control center as quickly as possible and be relayed immediately to the local responsible water official, whose duty it is to get one of his employees to the scene immediately to shut off valves, to prevent loss of water, to make an estimate of the repair job, and to arrange for repairs as speedily as possible.

It is the duty of local water officials to see that proper arrangements are worked out with local Directors of Civilian Protection for their representation at control centers.

Chapter V. Organization, Equipment and Training of Water Main Emergency Repair Crews and Other Auxiliary Water Works Personnel

General. As previously indicated, each local water authority should be woven in as a part of the civilian protection organization in each community. Toward this end, local water authorities should confer with the local Directors of Civilian Protection and work out an arrangement whereby in each community the local water authority will be definitely integrated with the civilian protection organization, but directly responsible for handling of all emergency water supply problems and the training and supervision of all volunteer or other personnel assigned for emergency water duties.

In any emergency, with breaks in water mains occurring at several points over the system, the regular water department organization will be insufficient to cope with the prbolems and make repairs promptly. Therefore, organization of volunteer or reserve personnel for emergency water main repair work and other water duties is urgently recommended. To accomplish this, as previously pointed out, a Division of Water Main Emergency Repairs has been established in the office of the State Director of Civilian Protection. These emergency crews and particularly the foremen of such crews, but including laborers who are pre-assigned to them, should be instructed as to the stations to which they are to report in event of an air raid alarm or actual emergency and be thoroughly trained in their emergency duties.

Local plumbers are believed to possess in general the best qualifications of any local group for service as foremen of emergency water main repair crews. However, there may be other skilled persons who, with some training, would make good foremen. In some departments it may be found more desirable to develop an emergency organization utilizing regular employees as foremen of emergency repair crews.

Foremen of emergency repair crews and other key auxiliary personnel should be given a course of training by the water superintendent in line with the course recommended by the State Water Supply Coordinator, covering the details of the water system, location and characteristics of valves, methods of repairing breaks and disinfection of water lines, including the orthotolidine test.

If emergency plans contemplate the possible use of emergency water supplies involving use of temporary pumping and chlorination equip-

ment, then auxiliary personnel should be trained as operators of such equipment.

In general, the training of reserve personnel to serve as operators in water pumping stations and treatment plants is recommended, the necessary training to be supplied by the water superintendent and other regular employees. An adequate number of persons should be trained to shut off valves in case of broken mains or other water incidents, although generally the foremen of repair crews may be assigned such duties.

Naturally, the organization of reserve water men, repair squads, etc., calls also for the planning and organization of all equipment and tools which will be needed on emergency work.

Recruitment of Auxiliary or Volunteer Personnel.

The local civilian mobilization representative is responsible for the recruiting and assignment of all volunteer personnel in the civilian protection service. This includes personnel assigned as foremen or members of water main emergency repair crews. Local water superintendents, therefore, should requisition volunteer and auxiliary personnel having the prescribed qualifications from the local volunteer participation representative.

In some cases water departments may prefer to enroll and train auxiliary personnel under some arrangement of compensation for their services. In these cases, since the auxiliary personnel are not volunteers but paid employees of the water department, they need not be registerd at the volunteer office. However, all volunteer personnel who may have been directly enlisted heretofore by the local water officials should be registered and reassigned to them by the local volunteer office.

Qualifications for Volunteers.

The State Water Supply Coordinator has notified the State Director of Civilian Mobilization of the qualifications required of volunteers assigned to water service duties as follows:

For Foremen of Water Main Emergency Repair Crews. The local water superintendent will first utilize as foremen of such emergency crews such regularly employed members of existing water main repair crews as he considers as having the qualifications to act in such a capacity. These regularly employed persons are not to be enrolled by the civilian mobilization representatives for any other of the civilian protection services.

The local civilian mobilization representative shall consult with the local water superintendent as to the number of volunteer foremen required under the local circumstances and shall proceed to enroll such volunteers for water service duty. The qualifications for all volunteer personnel assigned for training and duties as foremen of water main emergency repair crews shall be as follows:

a Persons who are licensed to practice as master plumbers.

b Journeymen or apprentice plumbers who are recommended by their employers as competent to supervise water main repairs after some training and under general supervision of the water superintendent.

c Persons with previous experience as steamfitters or in the laying or repair of water, gas, oil, steam or other pipe lines.

d Other persons with qualifications acceptable to the local water superintendent. The local water superintendent shall have authority to refuse to accept for such emergency service any enrolled volunteer whom he considers by reason of age or for other reasons unsuited to serve as a foreman of a water main emergency repair crew.

Members of Water Main Emergency Repair Crews. If a common labor pool is organized to furnish laborers to all local emergency utility services, the local water superintendent will draw upon the same to the extent which he requires at the particular time of the emergency. If common laborers are recruited and assigned in advance to serve as members of water main emergency repair crews, they shall have the following qualifications:

a Robust physical condition, with ability to handle heavy pipe and perform hard manual labor and handy with the pick, shovel and other ordinary tools.

Turncocks or Valve Operators. The local water officials should include within their emergency organization a sufficient number of trained men who can be assigned immediately to the scene of any reported water incident for the purpose of shutting off water valves and making estimates of the repair jobs. The local civilian mobilization representative should confer with the local water authorities as to the recruitment of personnel for this purpose. The qualifications for personnel to be assigned to these duties are the same as those prescribed for foremen of water main emergency repair crews.

Some local water officials may prefer to utilize the foremen of repair crews for this service, preliminary to effecting the necessary repairs.

Other Auxiliary Volunteer Water Service Personnel. The local civilian mobilization representative shall consult with the local water superintendent as to volunteer personnel which will be needed for service in connection with an organization to provide door to door distribution of water in the event of a complete water failure, for personnel required to serve as operators of temporary water treatment plants established on emergency water supplies, and for personnel required for any other emergency water service duty as may be indicated by the superintendent of water as necessary. The qualifications of all such volunteer personnel to be utilized in connection with such services shall meet with the approval of the local water superintendent, but in general shall conform to the following:

a **Supervisors of Emergency Water Delivery Service.** At least a high school graduate with some knowledge of chemistry and practical experience in the direction of a small group of workmen. Must be intelligent and have the ability to learn the fundamentals of the handling of water and the disinfection of water and equipment after a short course of training.

b **Operators of Temporary Chlorination Plants.** Persons with some previous experience in the operation of mechanical equipment such as pumps, motors, refrigerating or other small machines. Must be sufficiently intelligent to master the fundamentals of water treatment after a short course of training.

Extent of Auxiliary or Volunteer Personnel Required.

Water Main Emergency Repair Crews. In the event of a wide scale bombing attack and breakage of water mains in scores of places, probably no organization of water main emergency repair crews which the local water superintendent could organize and train would be sufficient to cope adequately with the local situation without assignment of many other emergency crews from unaffected areas. The Mutual Aid Plan for Water Service makes provision for the extension of such assistance from unaffected areas to stricken areas during emergencies through requests made to the Zone Coordinators. But to operate effectively, this particular feature of the Mutual Aid Plan requires that such water main emergency

repair crews be organized, trained and developed in each community of the state.

In any community the ability of the local water authorities to effect prompt repairs to broken water mains under the conditions of a severe bombing attack will vary somewhat in proportion to the number of trained emergency water main repair crews available for such service. In recognized target areas there is need for a greater number of these crews than in isolated communities which are considered well outside of likely target areas.

No hard and fast rules concerning the number of such emergency crews which should be developed and trained in each community and the equipment with which each should be supplied can be given, but the following are set forth for guidance of local Directors of Civilian Protection and local water authorities in the consideration of this matter.

a **Personnel.** A water main emergency repair crew shall consist of one foreman and 6 members. Local superintendents may increase or decrease the number of members as they deem advisable.

b **Equipment.** The principal items of equipment available to each crew should consist of as much of the following as is possible to assemble, carefully stored in the water department or allocated by the local director so as to be readily accessible to each crew at any time:

Map or other record of pipe and valve locations and sizes in possession of crew foreman.

One light truck (If not regularly in use by water department, the local director should allocate one truck for each crew under an arrangement whereby such truck would be made immediately available to the crew foreman upon request.)

Cleaning rods and equipment.

Chlorinating supplies.

Portable power pump with suction and discharge hose. (In some instances it may be necessary to rely upon getting portable pumps from unaffected communities through the Zone Coordinator during the emergency.)

Portable hand pump.

Portable lights.

Wooden or steel sheeting and other lumber.

Trench jacks and braces.

Paving breaker.

Gasoline engine driven compressor.

Valves.

Rubber boots, coats, hats and gloves.

Hardware, including nails, bolts and nuts.

Valve boxes.

Sand bags.

Brick, cement, sand and gravel.

Warning signs.

Dynamite, blasting caps, and fuses where rock may be encountered.

Pipe cleaning equipment.

Shovels, picks, bars, trowels, hoes, axes, drills, hammers, mauls.

Rope with hook attached.

Scrapers.

Saw.

Derricks.

Chain and falls.

Pipe and fittings.

Pails.

Lanterns and batteries.

Canvas.

Wheelbarrows.

Rope.

Wire cable.

Chains.

Grease, oil, gasoline and kerosene.

Note: In the larger cities several sets of the above equipment should be available. The above list is based upon recommendations of the American Society of Civil Engineers, Sanitary and Public Health Engineering Division of the National Committee of the Society on Civilian Protection in Wartime.

With reference to valves, pipes and fittings based upon the median inventories as they now exist in New York State municipalities, the following unit items should be available for the stated populations in each municipality to conform to average practice. Municipalities (particularly those situated in target areas) with valves, pipes and fittings less than the following indicated averages should give serious consideration to increasing their inventories. In this connection,

the State Water Supply Coordinator and the Zone Water Supply Coordinators will assist in the establishment and maintenance of such supplies and the obtaining of priorities for additional supplies and equipment which are needed by the local water authorities.

Unit Item	*Population Per Unit Item*
Hydrants	2,000 per each spare hydrant
Valves	660 per each spare valve
C. I. pipe	8 per each foot of pipe
Tees	560 per each spare tee
Crosses	2,200 per each spare cross
Bends	315 per each spare bend
Solid sleeves	475 per each solid sleeve
Split sleeves	1,130 per each split sleeve
Tapping sleeves	4,600 per each tapping sleeve
Reducers—Increasers	1,050 per each reducer or increaser
C. I. Branches	13,000 per each branch
Couplings	2,000 per each coupling
Plugs	740 per each plug
Caps	6,200 per each cap
Offsets	3,500 per each offset
Portable pumps	4,300 per each pump
Compressors	13,000 per each compressor
Tapping machines	5,000 per each machine
Cutting machines	12,000 per each machine

The above are based on present inventories as maintained by New York State municipalities. There should be sufficient variations in sizes of unit items to conform to local distribution system requirements.

Under the restrictions of the War Production Board P-46 Order as revised October 10, 1942 and subsequent orders, it is recognized that it will be impossible for water departments to obtain replacements or increased inventories at the present time.

c **Ratio of Repair Crews to Population.** In England, under bombing attacks, water distribution systems have suffered breaks in a ratio as high as 1 per mile of pipe. What may occur in American experience is not predictable, but it is hardly imaginable that bombings of American cities will be as severe as those which have occurred in England. It is suggested that as a start the number of emergency repair crews which should be organized, developed and trained for communities in or within 10 miles of likely target areas be based on the following table, which indicates the number of emergency water main repair crews needed for municipalities of stated population ranges:

Population Ranges	No. of Emergency Repair Crews Needed
Less than 2,000	1
2,000 to 5,000	2
5,000 to 9,000	3
9,000 to 14,000	4
14,000 to 20,000	5
20,000 to 28,000	6
28,000 to 34,000	7
34,000 to 42,000	8
42,000 to 49,000	9
49,000 to 75,000	10 to 12
75,000 to 100,000	12 to 15
100,000 to 200,000	15 to 24
200,000 to 300,000	24 to 32
300,000 to 400,000	32 to 40
400,000 to 500,000	40 to 48
500,000 to 600,000	48 to 54

In the case of municipalities considered to be within 10 to 20 miles of likely target areas, in order to create a nearby reservoir of emergency crews which can be quickly dispatched to stricken areas, emergency crews numbering about 50% of those indicated above should be organized.

In the isolated communities considered to be well removed from possible target areas, the need for organization of emergency crews will be much less. But each such community should proceed to have at least one emergency crew organized and trained.

Courses of Training.

The State Water Supply Coordinator and Zone Coordinators will supply local water superintendents with a syllabus to be used as a guide in the training of auxiliary and volunteer water works personnel as soon as such material can be prepared and distributed. In the meantime, local water superintendents should proceed with the organization and training of water main emergency repair crews to such extent as they are able to do without the aid of such instruction material. It is believed that most local water superintendents are capable now of training auxiliary or volunteer personnel in the fundamentals of their emergency duties. The following suggestions are made:

Foremen and Valve Operators. For persons who are to serve as foremen of water main emergency repair crews or as valve operators the instruction should include:

a Details of the distribution system including information on the accurate location of valves and hydrants, the particular characteristics of valves and hydrants and methods of manipulating valves so as to avoid damage, and the location of all materials and supplies which may be needed for repair jobs.

b The methods of making pipe repairs under various simulated conditions of rupture, including the dewatering of craters, the bridging or bypassing of craters, the methods of sheeting, use of flexible sleeves, methods of pipe cleaning, methods of capping, jointing, etc.

c Methods for disinfection of water pipes following repairs and before water service is resumed, using either portable chlorination equipment or powdered hypochlorites.

d Methods of making residual chlorine tests to test adequacy of disinfection.

e So far as possible, use practical demonstrations to illustrate methods and have the prospective foremen perform the work themselves to gain experience.

f Upon completion of the course of instruction give them an examination to test their knowledge of information given in the course.

Such a course of instruction should be carried on and cover a total of at least 30 hours or as much longer as is necessary to fully acquaint the proposed foremen with their duties. It would seem desirable to organize a class for foremen with 2-hour class sessions conducted at least once each week or preferably twice each week.

Emergency Water Delivery Supervisors and Temporary Treatment Plant Operators. For persons who are to render service as supervisors of emergency water delivery services or as temporary treatment plant operators, the course of instruction totaling about 30 hours should cover the following:

a Fundamentals of chlorination process and its relation to health.

b Techniques of chlorination methods, of making chlorine residual tests, care and operation of chlorination equipment, and the essentials of operation reports.

c Significance of bacteria in water and the various circumstances under which contamination may occur.

d The care and dinsinfection of equipment used in the handling and transportation of water.

e Batch disinfection of drinking water.

f Organization of equipment and personnel for either temporary treatment plants or emergency water delivery services.

g Construction of a barrel-type or homemade chlorinator.

h Practice in the existing treatment or purification plant alongside experienced operators.

Blackout Arrangements.

Water plants, pumping stations, etc., should be prepared to operate under blackout conditions. Windows should preferably be equipped with light-proof removable screens or blacked out by painting. Reduction of inside illumination to the minimum amount actually required will be helpful in this connection. Consideration should be given to additional protective measures required to compensate for loss of protective illumination during blackouts.

Duplicate Equipment.

Duplicate chlorinating equipment, or at least spare parts for pumps and chlorinators, should be maintained if possible to assure continuation of service in the event of breakdowns.

Chapter VI. Technical Problems Associated With Water Supply Emergencies

Wilful Contamination with Pathogenic Organisms.

While theoretically possible, this is considered to be only a remote possibility. There are many factors which make sabotage of water supplies through such means seem highly improbable. So far as we know, such attempts have not been made abroad so far.

The rigid control exercised over the handling and shipment of pathogenic cultures through the provision of the Federal Postal Law and of Article 23 of the New York State Public Health Law, and the control over aliens exercised by federal authorities, are factors which will militate against such a practice. Furthermore, if applied ahead of effective chlorination treatment, most organisms that can possibly be conceived as useful or available to the saboteur would be killed. Efficient operation of treatment plants provides the greatest safeguard. Other measures adopted for protection against sabotage, such as guards at reservoirs, roving patrols, etc., are also important factors which make such attempts at wilful contamination appear highly improbable.

Possible Contamination with Poisons.

For those water authorities who would feel compelled to carry on some tests for the detection of possible poisons, four suggestions are offered:

Test for Effect on Fish. Fish are killed by most poisons in concentrations well below those which are toxic for humans. Therefore, a fish aquarium will serve as a good detector in water treatment plants, provided the aquarium is supplied with raw water and fitted with a thermostatically controlled heater to equalize the temperature of the water coming in contact with the fish, and provided the mineral content, oxygen content, etc., does not fluctuate so rapidly as to destroy the fish. Fish aquaria established throughout a community would amplify the information so secured, provided the conditions are favorable for the continued wellbeing of the fish under normal conditions. This procedure, therefore, should be used with considerable discretion, otherwise undue alarm may be created by the death of fish due to natural causes.

Taste and Odor Test. Most poisons if present in toxic concentrations will create unusual tastes and odors. Therefore, any sudden change in taste and odors of the water would be a good reason for examining into the matter more carefully. Routine taste and odor tests made on samples of water evaporated to dryness would be helpful in this respect.

Chlorine Demand and Oxygen Consumed Value. Many poisons if present in water in toxic concentrations will increase the chlorine demand and oxygen consumed values of the water in excess of about 5.0 p.p.m. Tests for chlorine demand and oxygen consumed values, therefore, are helpful, provided the normal range in values is well established and the information so secured is properly interpreted.

Copperplate Test. For detection of heavy metals, a copper plate suspended in a sample of the water will show no discoloration after a few hours if heavy metal poisons are absent. If the copper plate builds up a significant deposit in a few hours, poisons may be present. Copper plates suspended in small tanks of water at the plant or in a few houses throughout the community would seem to be of some use in detecting heavy metal poisons.

Control over Treatment Processes.

During the war there should be a tightening of controls, particularly over chlorination treatment. Chlorine equipment should be visited and adjusted several times each day, so as to assure that the equipment operates continuously, with the dose applied sufficient to meet the peak chlorine demand occurring during the periods between visits and adjustments.

Chlorine demand tests of the raw water should be made routinely over a sufficient number of days each year and during different seasons of each year, so that normal variations are known and a schedule for dosage adjustment can be worked out which will assure sufficient dosage at all times.

Chlorine dosage should be such as to give not less than 0.15 p.p.m. residual after a 15 minute contact period, provided a frequent adjustment of equipment is made. Where visits to chlorinators can be made only once or twice each day the dosage should be increased to produce a residual of not less than 0.25 p.p.m. Elevation of the dosage will help assure against lapses in treatment due to fluctuating chlorine demands of the raw water.

Errors of the orthotolidine test due to interfering substances, such as manganese and nitrites, should be determined for each local condition and proper allowances for such errors made in adjusting the treatment process.

Laboratory Control During Emergencies.

Due consideration should be given to planning for any modified laboratory control which might be necessary under specific local conditions, in accordance with the following advice.

Laboratory examinations are an index of the effectiveness of the type or degree of treatment employed. During periods of emergency the problem of the frequency of sampling of water supplies is always pertinent. It can usually be assumed that any damage to a water supply by floods, earthquakes, or military attack will contaminate the water. The most satisfactory procedure in such instances is to apply emergency methods of treatment that will produce a safe water, using laboratory examinations only to confirm the results of the emergency treatment and to indicate when the need for it has passed.

Sampling of public water supplies should at all times be made as frequently as local conditions and the methods of treatment necessitate. It should be remembered, however, that the examinations do not in themselves improve the character of the water nor do they indicate the condition of a given supply except at the time and place of sampling. The sampling stations must be selected with care to insure the collection of representative samples; the interpretation of the laboratory results depends in turn upon the frequency of examination and on the conditions known to exist at the time of collection. Thus an increased frequency of sampling will give more reliable information relative to the quality of the water. Undoubtedly the examination of additional samples from a supply is desirable in emergencies —either to confirm suspected contamination or to assure the consumers that the water is of its usual satisfactory quality.

Superintendents and operators of public water supply systems should be informed as to laboratory services that may be used in case of emergencies. In accordance with the provisions of the Public Health Law, laboratories in New York State that have met qualifications as to equipment, personnel, and standards of work are approved by the State Commissioner of Health for the bacteriologic examination of water. These include county, municipal, private and hospital laboratories. A list of approved laboratories is published annually by the Division of Laboratories and Research of the New York State

Department of Health, and information as to available laboratory service in any area can readily be obtained from the district sanitary engineer or the zone coordinator of water supplies. In order to be prepared for any contingencies, persons in charge of public water supplies should obtain this information as promptly as possible and confer with the laboratory in that area to determine the services it can give both routinely and in case unusual conditions prevail. These laboratories have many responsibilities and the sampling schedule should be so arranged that it will not tax their facilities to the detriment of other important public health examinations. When arrangements for examinations have been made, instructions regarding the collection and submission of samples should be obtained and a supply of approved containers kept on hand at the headquarters of the water supply, so that samples suitable for examination can be promptly forwarded to the laboratory. Cooperation between the water supply operator and the laboratory director should result in adequate control of the quality of the water supply, not only during emergencies resulting from military destruction or natural disaster but also under normal conditions.

Maintenance of Residual Chlorine.

This is desirable wherever it can be accomplished without leading to objectionable tastes and without greatly increasing present chlorine consumption. However, due to the present chlorine manufacture and supply situation and the need of greatly increased quantities of chlorine in most cases to get a residual through the system, the practice on a wide scale must be discouraged for the time being. There are some supplies, however, where with only a slight increase in dosage a residual throughout the system could be developed and in such cases this would be desirable.

Residuals produced by the improved methods of superchlorination, generally referred to as "break-point" chlorination, have a disinfecting power many times that of residuals of the same order produced by ordinary methods of chlorination. Furthermore, experience has shown that residuals up to 1 to 2 p.p.m. produced by improved principles of superchlorination can be carried in some waters, not only without producing objectionable tastes but with beneficial effects in overcoming taste and odor problems, elimination of aftergrowths and gas formers, etc. In most cases, however, to reach the point of complete satisfaction of the chlorine demand, much higher doses of chlorine must be used than are currently employed. Such residuals

of a relatively high order do give a considerable amount of protection by neutralizing the effects of secondary contamination introduced in distributing systems through such things as hidden cross-connections, back siphonage from defective plumbing fixtures, or contamination introduced at the time of making repairs to the system.

Great extension of superchlorination practice cannot be recommended under present conditions, due to the present restrictions on chlorine supplies and equipment. It is advisable, however, that local water authorities give the matter their serious study and consideration now, to find out whether or not the process is adaptable to their local conditions, and the amount of equipment and chlorine that would be needed in the future or in the event that under pressure of war conditions it becomes necessary to resort to heavy chlorination. If military authorities should order increased treatment of municipal water supplies throughout certain areas that may be declared military zones, full knowledge in advance concerning the methods and applicability of the superchlorination process would offer hope in many places that high residuals could be carried throughout the system without taste and odor difficulties.

Where chlorine-ammonia treatment is employed but superchlorination is not practiced, the ammonia dose should be kept at a minimum to insure adequate disinfecting power of the chloramine residual. In no case should the ammonia dose be greater than 25% of the chlorine dose and the chloramine residual should be at least 0.5 p.p.m. Chloramines have poor disinfecting power in waters with high pH values. Therefore in general, chloramination should not be used on water having pH values much in excess of 7.4.

Ammonia doses of approximately 1/10 the chlorine dose, not the usual 1 to 3 ratio, may have to be added to waters of low chlorine demand (organic content) to secure desired superchlorination reactions and to produce active, stable residual chlorine.

The Flash Orthotolidine Test.

The results of this test will provide a practical demonstration the superchlorination or so-called "break-point" chlorination reactions are occurring. A flash residual will develop only after sufficient chlorine has been added to reach and slightly exceed the total chlorine demand of the water. The test is performed as follows:

1 Place *twice* the usual quantity of orthotolidine reagent in the sample tube or bottle of the o.t. test kit.

2 Add the chlorinated sample to tube or bottle and mix.

3 Take the color reading within 15 seconds.

4 Then place the sample in the dark for 4 minutes and 45 seconds and take the color reading again after a total elapsed time of 5 minutes.

5 If the color reading after 15 seconds is more than 80% of that developing in 5 minutes, the residual is beyond the so-called "break-point" and is in the most active germicidal state. Ratios lower than 80% indicate that the residual is less active and with a much lower disinfecting power.

Terminal Chlorination at Open Equalizing Reservoirs.

The chlorination of water entering open equalizing reservoirs may be effective in some cases, although sunlight and storage complicate the maintenance of residual chlorine throughout the reservoir. Terminal chlorination, therefore, is preferable. The extreme fluctuations in rate of flow and the reversal of flow when single influent-effluent mains are connected directly to distribution systems require the use of special chlorination equipment designed for this specific purpose. The reversal of flow of water may be prevented by the use of a short bypass around the point of chlorination and through the use of two check valves so installed that the entering water flows through the bypass and is not chlorinated; whereas the water leaving the reservoir would flow past the point of chlorination, thus permitting the use of conventional automatic chlorinators with minor changes. While restrictions on equipment will operate against the general installation of new equipment of this character, such treatment should be applied to the water, leaving open equalizing reservoirs serving defense connected communities.

Chlorination of Mains Following Repairs, Etc.

This is required by the State Sanitary Code, Chapter V. Mains undergoing repairs or new mains as they are laid are subject to pollution through seepage of ground water or sewage, and chlorination is the only effective means of counteracting such contamination. In making repairs or laying new mains, precautions should be taken to guard against these possibilities and insure clean pipes.

Before a new main or a repaired section is placed in service, disinfect with a dose of chlorine containing approximately 50 parts per million, so as to give a deep red color by the orthotolidine test.

Chlorine preferably should be applied by a portable chlorinator, so arranged that gaseous chlorine or hypochlorite solutions are introduced into the water used to fill the new pipe or repaired section.

The simplest procedure is to inject a heavy dose of chlorine through a corporation cock as the pipe is being filled, and make an o.t. test on the water when it arrives at the first fire hydrant below the point of application. Upon assurance that the heavy dose has been applied throughout, shut the water off and allow the heavily treated water to stand in the main for at least 30 minutes and preferably for several hours. To get house services disinfected which may have been subjected to contamination through back siphonage from defective plumbing fixtures, particularly in the larger buildings, during the time that the water has been shut off to such buildings it is advisable to notify water consumers not to use the water for drinking purposes without boiling until the disinfection of the pipes is completed. To disinfect the house services, the chlorine feed through the corporation cock should be continued after the water is again turned on until heavily chlorinated water is obtained at consumer taps, following which chlorination should be discontinued and the system thoroughly flushed, both at the fire hydrant and at the consumers' taps.

Under bombing conditions and at night, when breaks occur and blackouts are in effect, the English authorities have found it best to shut off the damaged section and wait until daylight to begin repairs. They have also found that the placement of liberal quantities of powdered chlorine compounds in sections of the repaired pipe is a simple method of securing disinfection under war conditions.

While portable chlorination equipment for injection of gaseous or chlorine solutions into mains under pressure through corporation cocks is desirable as a normal procedure, and while portable equipment for such purpose is generally advisable in the larger communities and defense connected municipalities, a good job of disinfection can be done through dosing specified lengths of new or repaired pipe with powdered hypochlorite compounds. This method has the disadvantage, however, of being rather cumbersome, particularly in regard to getting heavily chlorinated water throughout house piping systems situated along the main which has been shut off. The following table gives the ounces of powdered chloride of lime, (not calcium chloride) H.T.H. or Perchloron needed for various lengths of pipe of different diameters to produce a dose of about 50 p.p.m.

Diameter of Pipe	No. of Lengths of Pipes Per Application	Ounces of Chloride of Lime Per Dose (25% Available Chlorine)	Ounce of H.T.H. or Perchloron Per Dose (65% Available Chlorine)
4	4	1.0	0.5
6	4	2.5	1.0
8	3	3.0	1.5
10	4	7.0	2.5
12	3	7.5	3.0
16*	2	9.0	3.5
18	3	12.5	5.0
20	2	10.5	4.0
24	2	15.0	6.0
30	2	23.5	9.0

* Pipes less than 16 inches in diameter have lengths of 16 feet. Larger pipes have lengths of 12 feet.

Chlorination of Tanks, Standpipes, Reservoirs.

Clean the walls and bottoms thoroughly and use one of the three following methods:

First Procedure. Prepare a disinfecting solution of 200 p.p.m. available chlorine by adding 1 ounce of chloride of lime to 10 gallons of water, or 1 ounce of H.T.H. or Perchloron to 26 gallons of water, or 1 gill or ⅛ quart of liquid bleach (sodium hypochlorite) of 5% strength to 8 gallons of water. The powders should be made into a paste with a small volume of water and the paste mixed with stated volumes of water. Spray the resulting solution over the inner surface of the empty structure or apply through the use of a wide brush. Do not fill the structure with water until at least 30 mintues have elapsed.

Second Procedure. Add to the water used to fill the repaired or new structure sufficient chlorine to provide a dose of 50 p.p.m. This requires 1½ pounds of chloride of lime or ½ pound of H.T.H. or Perchloron for *each* 1000 gallons needed to fill the structure. Mix the powder into a paste and mix batches of the paste with the water as the structure is filled. Allow the heavily disinfected water to act for at least 30 minutes and preferably for 6 hours before being replaced with potable water.

Third Procedure. Use a portable chlorinator to apply a dose of approximately 50 p.p.m. chlorine to the water flowing through the

influent pipe of the structure. If the *rate* of flow of water is unknown, base the dose upon the rate of rise of water in the structure to give approximately 50 p.p.m. This should provide a concentration of residual chlorine sufficient to give a deep red or brown color with the orthotolidine reagent. Allow the heavily disinfected water to act for at least 30 minutes and preferably for 6 hours before being replaced by potable water.

Emergency Water Delivery Service.

To be fully prepared for an extreme emergency, when a complete water failure may occur, it is advisable to set up an organization and plan in advance for the delivery of drinking water to residents during the period of the water shut-off through the use of tank trucks, etc. These should be worked out in cooperation with the local Director of Civilian Protection and the local health officer.

It is important that persons who are to be assigned to such a job during a water failure be thoroughly trained in advance as to the precautions which must be taken in handling water, disinfection of equipment, etc. The local water officials should undertake to train the volunteers who may be assigned to such service and include in this instruction the procedure for making residual chlorine tests.

All of this requires considerable advance planning and organization, including the spotting of equipment which will be needed in connection with an emergency water delivery service.

Milk tank trucks if available are ideal for such purpose, or milk cans in trucks may serve equally well if precautions are taken to avoid contamination during handling and to disinfect such cans following their use. Sprinkler wagons or trucks may also be used, but these should be disinfected if they have been used previously to haul unsafe water. Gasoline trucks may also be used, but generally they will require several flushings and perhaps steaming before the odor of gasoline is eliminated.

All such equipment should be disinfected either with live steam or by chlorination, using a solution of at least 50 p.p.m., in a manner similar to the procedures given above for tanks and reservoirs.

Milk cans may be disinfected either with live steam or by chlorination. Make a paste with one ounce of chloride of lime, H.T.H. or Perchloron and thoroughly mix with 10 gallons of water. Or add one gill or ⅛ quart of 5% strength liquid bleach to 8 gallons of water. Use this solution to disinfect the inside of the cans. As an alternate, the cans may be immersed in a barrel of disinfecting solu-

tion prepared by mixing 5 ounces of chloride of lime or 2 ounces of H.T.H. or Perchloron with the 50 gallons of water in the barrel.

If the water to be transported is of unknown or questionable sanitary quality, arrangements should be made for the batch disinfection of the water to give a dose of at least 2.0 p.p.m. This dose may be secured by adding 1 ounce of chloride of lime or bleaching powder (not calcium chloride) to 1000 gallons of water, or 1 ounce of H.T.H. or Perchloron to 800 gallons of water, or one gill of 5% strength liquid bleach to 800 gallons of water. In case of doubt, increase the dose of disinfectant until the taste of chlorine is noted, unless control with the o.t. test indicates the presence of at least 0.5 p.p.m. residual chlorine after a reaction period of at least 15 minutes.

Water placed in milk cans may be disinfected by using liquid bleach (usually 5% available chlorine) in accordance with the following table:

Size of Milk Can Quarts	*Number of Drops of 5% Liquid Bleach or Sodium Hypochlorite*
8	4
20	10
40	20

Instructions to Local Residents.

It seems advisable for each local water authority to secure cooperation of the local organization and local health officers in disseminating instructions to residents concerning use of water in an emergency. It is suggested that simple instructions be printed on a card and distributed to consumers for posting in their homes. Following is a suggested draft which outlines the principles which should guide local residents as to use of water during air raid alarms or actual emergencies:

IMPORTANT NOTICE

These rules are for your protection in the event of air raid warnings, blackouts or actual emergencies. Please read them carefully and post in a conspicuous place in your home.

DURING BLACKOUTS OR AIR RAID ALARMS

1 Use water sparingly and only for urgent purposes. Keep faucets closed. *Do NOT fill bathtubs or other containers during or immediately following air raid alarms.* Water for fire quenching purposes should be drawn and stored in containers on the premises well in advance of alarms.

2 Do not tamper with main house piping system shut-off valve.

DURING ACTUAL BOMBING ATTACKS

1 After bombs begin to fall or when instructed by authorities, boil or disinfect all drinking water until further notice. Boiling for 2 minutes is ample. Water may be adequately disinfected by adding to each gallon of water 2 drops of one of the laundry bleaches (5% available chlorine) such as Chlorox, Dazzle, White Sail, Rainbow, Savo, Rose-X, or add 4 drops of bleaches like SK or "101 solution" (2½% available chlorine) or add 10 drops of Zonite (1% available chlorine) to each gallon of water. Mix thoroughly and let the disinfected water stand for 30 minutes before use. If these doses do not give a slight chlorine taste after 30 minutes standing, add additional drops of the solution.

2 Avoid drawing water or use of toilets except for urgent reasons. The fire department must be assured of full use of all water in the system during an actual emergency.

3 If home is damaged and water pipes are broken, then and only then shut off main valve on house piping system. If this is necessary, be sure to damper all fires to hot water heaters and steam boilers, turn out all pilot lights, etc.

4 Don't phone the water department in case water is shut off, but be sure all house faucets are closed.

5 Don't use toilets if water service has ceased unless you carry water from some other source to fill the flush tank.

COOPERATE BY OBSERVING ABOVE RULES

Priorities as to Materials and Equipment.*

War Production Board has recently issued preference rating order P-46 revised as of October 10, 1942.

It is to be regretted that complete instructions have not yet been made available by the War Production Board regarding an exchange of materials by water works authorities as required by this revision of the P-46 order.

New and higher preference ratings are now assigned by P-46 order. Deliveries of water works materials for normal maintenance and repair and for sabotage protection are assigned an AA-5 rating. Deliveries for emergency repairs are assigned an AA-2X rating.

The order also defines "inventory" which is subject to the control of deliveries and withdrawals as set up under the order. Other limitations of the order covering withdrawals and purchases of materials from manufacturers and from other water works surplus inventories are too complicated to be discussed in this Manual. Furthermore, as indicated above, the War Production Board has not as yet issued complete instructions as to interpretation of the order in detail.

Briefly, however, the order does require water works authorities to limit their inventories of water works materials to 60% of the dollar value of the 1940 figure for those items of water works materials relating to maintenance and repair. The purpose of this is to enable water works of the country to exchange material without much drainage on manufacturers' facilities of the country during the next six months or a year, whereby the full capacity of those manufactures can be diverted to the war effort. When further clarification of the interpretation of the new order is received from the War Production Board, it will be made available to the water works authorities of the State.

The use of priority application blank forms PD-1A for minor extension and form PD-200 and 200A for major new construction is continued. It is indicated, however, that approval of applications by the War Production Board for new construction will be greatly and increasingly restricted during the coming year in the interest of devoting the full capacity of industries to the war effort.

Instructions for making applications and application blanks may be obtained from the Power Branch of the War Production Board, Social Security Building, Washington, D. C.

* The information contained herein relating to prorities procedure is now out of date. The P-46 order has been replaced by order U-1 which sets up new ratings and inventory restrictions.

Priorities Under Mutual Aid Plans.*

The War Production Board recognizes the value of mutual aid plans during the war emergency. To facilitate the securing of materials and equipment for the execution of such plans, the following procedure has been developed by J. A. Krug, head of the Power Division, War Production Board, Social Security Building, Washington, D. C.

When a water department or utility must obtain materials or equipment for the emergency maintenance or repairs of public water supplies they should: (a) make a telegraphic request to the Power Division, War Production Board, Washington, D. C., for an emergency preference rating for the needed material, or (b) obtain the needed material under mutual aid procedure by loan from a neighboring water utility. In the latter case, the State Water Supply Coordinator or Zone Coordinator must file with the Power Division a telegraphic request for an emergency preference rating or ratings to cover the purchase of item or items taken from the stock of the specified water department or utility. This request should record: (1) the nature of the emergency; (2) the material used; (3) the location where installed, and (4) the name and address of the water department or utility from whose stock the material was obtained. The water department or utility in turn will be granted the necessary preference rating. The formal application for such rating will be in accordance with the provisions of preference rating order P-46 and should be filed on application form PD-1A for minor items, or on forms PD-200 and PD-200A when an application for a special "Project Rating" is to be submitted.

Priorities as to Chlorine and Chlorine Compounds.

General preference order M-19 applies specifically to gaseous or liquid chlorine. This order assigns a favorable preference rating of A-2 to chlorine used in the disinfection of potable water and sewage. Unlike other materials and equipment referred to above, liquid chlorine compounds containing available chlorine may be ordered for this specific purpose without use of special blanks or authorization, provided the order for chlorine to be delivered the following month is placed with a distributor before the 5th day or with the producer before the 10th day of the month preceding the month of delivery, and provided the order is for the amount of chlorine which would be

* The information contained herein relating to priorities procedure is now out of date. The P-46 order has been replaced by order U-1 which sets up new ratings and inventory restrictions.

consumed during a period of one month. Furthermore, such orders must be accompanied by a statement that the chlorine is to be used for the chlorination of potable water or sewage.

Chloride of lime and special high test hypochlorites are scarcer than chlorine and thus it may be difficult to secure these powdered disinfectants. Sodium hypochlorite solutions, however, are manufactured locally by using liquid chlorine, so that these solutions may have to be used in place of chloride of lime or high test hypochlorites when hypochlorite solution feeders are utilized. The manufacturer of chlorine and chlorine products should be consulted for information.

Chapter VII. The Preparation of Sewerage Facilities for Emergencies

The damages which may result to sewer systems and treatment works from bombing attacks or sabotage may be extensive and produce great discomfort and confusion in a community through disruption of sewer service. Although not as vital as the service of water supply, it is essential that sewer service be maintained effectively and that arrangements be made in advance for prompt repairs. This is particularly important in view of the fact that generally repair of sewers must be accomplished before permanent repairs to water lines are made.

In a bombing, sabotage or fifth column attack, destruction of pumping stations, force mains, or sewer lines may result in stoppages and backing up of sewage in sewer lines, causing flooding of basements and contamination of stored foods and creating gross nuisances by discharge of sewage into streets through surcharged manholes.

In bomb craters both water and sewer lines are apt to be broken, thus permitting contamination of water lines and flooding of craters with sewage. Destruction of a sewage treatment plant might cause serious public health hazards through the additional loads placed on water treatment plants downstream, although there are many precautions which can be taken to mitigate the seriousness of such an eventuality, such as stepping up treatment of the water supply and temporary chlorination of bypassed sewage.

To prepare in advance for such emergencies there is a need for organization, training and development of emergency sewer repair crews, the incorporation of the sewer department and its employees as a unit in the civilian protection organization under the local director of civilian protection and for an arrangement whereby the sewerage works personnel, equipment, materials and supplies of all sewer departments can be made available to stricken communities under a mututal assistance plan.

Mutual Aid Plan for Sewer Service.

Purpose. Prepare the State and all of its municipalities to effect and maintain sewer service under any emergency conditions.

Objectives. The specific objectives are briefly indicated as follows:

1 File a detailed inventory of sewerage works personnel, equipment, materials and supplies with a Coordinator, so that the resources

and facilities of all communities within each zone and within the State can be drawn upon to provide needed assistance promptly to any local sewer officials when confronted with a serious emergency.

2 Under the local Director of Civilian Protection incorporate sewer departments and their employees as a unit in the local organization and organize, develop and train emergency sewer repair crews to function in the repair and maintenance of sewers during emergencies.

Organization and Delimitation of Fields of Effort.

The Mutual Aid Plan for Sewer Service as approved by the Director of Civilian Protection provides for an organization and fields of efforts which are a counterpart although not as extensive as those provided under the Mutual Aid Plan for Water Service.

The State Water Supply Coordinator (Assistant Director of the Division of Sanitation) will serve also as a State Coordinator for Sewer Service. The sewer service zones are the same as the water service zones established under the Mutual Aid water plan, except in Nassau and Westchester Counties, the Zone Water Supply Coordinators will have no functions in respect to operation of the Mutual Aid Plan for Sewer Service. In the other counties, District Engineers of the State Department of Health will serve as Zone Coordinators.

Zone Coordinators of Mutual Aid Plan for Sewer Service.

Zone	*Counties*	*Coordinator*
2.........	Nassau	J. C. GUIBERT, Commissioner Department of Public Works Nassau County, Mineola J. L. BARRON, Director Division of Sanitation Nassau County Department of Health Mineola
3.........	Westchester	J. H. HARDING, Commissioner Department of Public Works Westchester County, White Plains R. M. MCLAUGHLIN, Director Division of Sanitation Westchester County Department of Health White Plains
4.........	Suffolk	W. H. LARKIN, District Engineer State Dept. of Health New York City
5.........	Albany Columbia Rensselaer Schenectady	W. J. ERICKSON, District Engineer State Department of Health Albany

Zone	*Counties*	*Coordinator*
6.........	Fulton Montgomery	R. S. Taggart, District Engineer State Department of Health Amsterdam
7.........	Genesee Orleans Wyoming	F. D. Zollner, District Engineer State Department of Health Batavia
8.........	Broome Chenango Tioga	A. Rihm, District Engineer State Department of Health Binghamton
9.........	Erie Niagara	R. D. Bates, District Engineer State Department of Health Buffalo
10.........	Ontario Seneca Yates	A. W. Eustance, District Engineer State Department of Health Geneva
11.........	Saratoga Warren Washington	W. R. Schreiner, District Engineer State Department of Health Glens Falls
12.........	Jefferson Lewis St. Lawrence	J. B. Belknap, District Engineer State Department of Health Gouverneur
13.........	Allegany Chemung Steuben	R. C. Gorman, District Engineer State Department of Health Hornell
14.........	Schuyler Tompkins	E. C. La Valley, District Engineer State Department of Health Ithaca
15.........	Cattaraugus Chautauqua	C. J. Bernhardt, District Engineer State Department of Health Jamestown
16.........	Greene Ulster	H. F. Edinger, District Engineer State Department of Health Kingston
17.........	Orange Rockland Sullivan	J. C. Haberer, District Engineer State Department of Health Middletown
18.........	Delaware Otsego Schoharie	H. F. Rock, District Engineer State Department of Health Oneonta
19.........	Dutchess Putnam	P. W. Simson, District Engineer State Department of Health Poughkeepsie

Zone	*Counties*	*Coordinator*
20.........	Livingston Monroe Wayne	G. W. MOORE, District Engineer State Department of Health Rochester
21.........	Clinton Essex Franklin Hamilton	J. A. STALBIRD, District Engineer State Department of Health Saranac Lake
22.........	Cayuga Cortland Onondaga Oswego	H. H. WAGENHALS, District Engineer State Department of Health Syracuse
23.........	Herkimer Madison Oneida	F. N. S. THOMSON, District Engineer State Department of Health Utica

Inventories. The manner and arrangement for handling inventories will be similar to that under the Mutual Aid Water Plan. Local sewer officials are to file inventories with the above listed coordinators and call upon them for assistance in the event of an emergency. All of this work will be handled largely outside of the framework of the State and local civilian protection organizations except that the State Director of Civilian Protection and local Directors will be kept informed concerning the progress of the work.

Relationship to Civilian Protection. In the field of civilian protection (organization, development and training of emergency sewer repair crews, etc.) the mutual aid organization will operate as a Division of Emergency Sewer Repairs under the direction of the State Director of Civilian Protection.

The arrangement will be identical to that discussed in previous chapters of this manual under "Division of Water Main Emergency Repairs" except for the substitution throughout of local sewer officials for local water officials, etc.

The State Coordinator is technical advisor to the Director of Civilian Protection and Zone Coordinators are technical advisors to local Directors and local sewer officials on all matters related to sewerage or sewage treatment.

The local sewer official or person in charge of the sewer system is the technical advisor and responsible directive authority of the local Director of Civilian Protection in relation to all emergency sewer service matters. The local sewer official will utilize regular

sewer department employees to perform and direct the functions of repairs and maintenance.

Recruitment of Volunteers. With reference to emergency repairs to sewers, the local sewer official will on behalf of the local Director have auxiliary or volunteer personnel enrolled and directed to this protective service by the Volunteer Office representative.

Standards for such enrollees as formulated by the State Coordinator and issued to the State Director of Civilian Mobilization by the Director of Civilian Protection are the same as formulated for volunteer personnel assigned to water service duties. The local Director will authorize and arrange for appropriate insignia for volunteer personnel assigned to emergency sewer service duty.

Training of Volunteers. It is the duty of the local sewer official to formulate plans for the organization and training of auxiliary or volunteer personnel to be utilized as foremen or members of emergency repair crews or in other capacities, and to furnish copies thereof to the Zone Coordinators. It is also a responsibility of the local sewer official to train the auxiliary or volunteer personnel in the duties and technical work required for the efficient performance of emergency work.

No syllabus or outline of a training course for use of sewer officials in training auxiliary personnel will be prepared by the State Coordinator, since the principles involved in making sewer repairs are relatively simple and without technical complications. Each local sewer official is regarded as competent to give volunteer or auxiliary personnel sufficient training to enable them to perform emergency work satisfactorily. Zone Coordinators, however, will give guidance and assistance in such training wherever it is requested. Local War Training Committees of the local War Councils will assist with instructional facilities such as classrooms, etc.

Channels of Communication. In respect to the channels of communication, these shall be the same as previously discussed under the Mutual Aid Water Plan, except "sewer official" shall be substituted for "water official."

Sewer Systems. Injury to sewers in streets, especially trunk sewers, constitutes a serious menace to public health, public comfort and possibly even the military effort itself. Therefore, attention should first be directed to prompt repairs of any street sewers that may be damaged by sabotage or bombing. While the damage from bombing may naturally be much more extensive than peace

time cave-ins, nevertheless the methods of repair do not vary much from ordinary routine. While in general repairs to damaged sewers would usually be of a permanent nature, there will be occasions when larger size sewer pipe is unavailable and it might be necessary to provide temporary wooden flumes to keep the sewer in service.

Where basements have been flooded due to broken sewers, they should not only be pumped out or drained but thoroughly washed, brushed and scrubbed with water, following which a disinfecting solution of chloride of lime should be applied. Curtains, rugs, furniture and clothing which have been flooded with sewage should be thoroughly cleaned, disinfected and if possible dried in the sunshine before being used again.

Sewage Pumping Stations. To prepare for possible damage to pumping stations or for power failure, it would be well to make provisions in advance for chlorination of the sewage and bypassing it to the nearest watercourse if such is available. In case of the smaller pumping stations, portable gasoline engine driven pumps should be provided.

Intercepting Sewers and Outfalls. Damage to these structures can frequently be relieved by use of temporary ditches or connections to nearby streams, with proper chlorination of the bypassed sewage. Where the stream is used as a source of public or industrial water supply below the point of discharge, the fact of such bypassing should be made known immediately to the water users.

Sewage Treatment Works. Power failure in highly mechanized sewage treatment works or actual physical damage to some of the units can probably be relieved only through arrangements for bypassing the various units and provision for heavily chlorinating the bypassed sewage. Here again the downstream water users should be notified immediately. These suggestions are largely remedial emergency measures and should not be looked upon as a permanent method of relief. The permanent relief measures should be taken after careful study of the extent of the damage, available materials for repairs, and the sanitary needs of the situation.

Personnel. The needs for duplicate man power cannot be overemphasized, and reference should be made to the section in the water supply part of this manual relating to Organization and Training of Repair Crews and Reserve Personnel. It is also believed that a list of local contractors should be kept and that some definite understanding should be made with these contractors so that they may be available on short notice with appropriate equipment and crews of men.

Chapter VIII. Preparations for Maintaining Safe Milk Supplies During Emergencies

The Problem. It is commonly recognized among health officials that the pasteurization of milk is the safeguard that is protecting the public against the spread of milkborne outbreaks of scarlet fever, septic sore throat, dysentery, gastroenteritis and typhoid fever, as well as against undulant fever which, however, ordinarily does not occur in epidemic form. Every effort should be made to maintain water supplies and power services to milk pasteurizing plants because of the importance of pasteurization and of milk as a food. Furthermore, the maintenance of this important and commonly used food supply is of considerabe importance.

Reports indicate that during the severe bombing of London, uninterrupted supplies of milk from country stations to plants and from plants to consumers were maintained. This had a very favorable effect on public morale. In the interest of maintaining morale and also of maintaining the normal food ration of workers and children, every effort should be made to maintain water and power services and to keep traffic lanes open to and from milk plants.

Purpose. The purpose of the Mutual Aid Plan for Milk Service is to prepare the State and all of its municipalities to maintain the safety of milk supplies and continuity of service during emergencies that may result from enemy action in one form or another.

Objectives. The specific objectives contemplated at present are as follows:

1 In the event of general destruction of pasteurizing plants or the general interruption of the water supply or electric services in a municipality, to make all preliminary arrangements for the prompt use of excess pasteurizing facilities or excess pasteurized milk in neighboring municipalities.

2 To locate at various centers and provide for the emergency use of private water and electric power sources, portable steam boilers, portable electric generators, milk trucks and any other equipment that may be needed to maintain pasteurizing and bottling operations in crippled milk pasteurizing plants.

3 To provide and when necessary to train emergency operators to supplement the regular workers in milk pasteurizing and bottling plants operating extra hours to do the work of a crippled plant or plants.

4 To make necessary studies and provisions to protect milk plants against sabotage and to prevent the chemical or bacterial contamination of milk by enemy agents.

5 To embargo any milk supply or portion thereof suspected as having been tampered with and to make provisions for having such milk promptly tested and released if found to be safe.

6 To collaborate with milk plant managers in investigating the loyalty of employees and in taking necessary precautions to keep unidentified persons out of their plants.

7 To collaborate with local civilian protection authorities and with milk plant operators in blacking out pasteurizing plants which are expected to be used in night operation during emergencies.

8 To make provisions for warning the public to boil milk or to pasteurize it at home in the event that it should be impossbile to supply pasteurized milk but should be possible to distribute it raw.

9 To make necessary preparation for providing an ample supply of safe milk on short notice to evacuees.

10 To cooperate with local directors of civilian protection in integrating work under the Mutual Aid Plan, with particular reference to making provisions for local health officers and, through them, local milk dealers and District Directors of Emergency Milk Supplies to receive prompt notification of damage to milk pasteurizing plants, water supplies, electric services and main arteries of traffic as a result of accident, sabotage or enemy action.

Organization and Delimitation of Fields of Effort.

The Mutual Aid Plan for Milk Service is organized along lines similar to the Mutual Aid Plan for Water Service.

The State Director of Emergency Milk Supplies appointed by the Governor is in charge of the program and has designated 22 District Directors of Emergency Milk Supplies and 777 local directors. The local directors are the local health officers. These workers receive no extra remuneration.

MILK SERVICE DISTRICTS AND DIRECTORS OF EMERGENCY MILK SUPPLIES

District	*Counties Included*	*Director*
State.........	All	W. D. TIEDEMAN, State Director of Emergency Milk Supplies New York State Dept. of Health, Albany *Associate Director* C. S. LEETE, Bureau of Milk Sanitation New York State Dept. of Health, Albany
Albany.......	Albany, Columbia, Rensselaer, Schenectady	J. F. MILLER, Dist. Milk Sanitarian New York State Dept. of Health, 217 Lark St., Albany
Amsterdam...	Fulton Montgomery	R. S. TAGGART, Dist. Sanitary Engineer New York State Dept. of Health, 268 Guy Park Ave., Amsterdam
Batavia......	Genesee Orleans Wyoming	H. W. SCORALICK, Dist. Milk Sanitarian New York State Dept. of Health, 35 State St., Batavia
Binghamton..	Broome Chenango Tioga	C. H. COLVIN, Dist. Milk Sanitarian New York State Dept. of Health, 709 Kilmer Bldg., Binghamton
Buffalo.......	Erie Niagara	N. J. HOHL, Dist. Milk Sanitarian New York State Dept. of Health, 65 Court St., Buffalo
Geneva......	Ontario Schuyler, Seneca Tompkins, Yates	M. P. KLOSER, Dist. Milk Sanitarian New York State Dept. of Health, Geneva Hospital, Geneva
Glens Falls...	Saratoga Warren Washington	R. O. SWANNER, Dist. Milk Sanitarian New York State Dept. of Health, 412 Rogers Bldg., Glens Falls
Gouverneur...	Jefferson Lewis St. Lawrence	A. W. PEACOCK, Dist. Milk Sanitarian New York State Dept. of Health, 172 Park Ave., Watertown
Hornell......	Allegany Chemung Steuben	W. F. ALEXANDER, Dist. Milk Sanitarian New York State Dept. of Health, Highway Building, Hornell
Jamestown...	Cattaraugus Chautauqua	W. M. ALLEY, Dist. Milk Sanitarian New York State Dept. of Health, 601 Hotel Jamestown Bldg., Jamestown
Kingston.....	Greene Ulster	H. F. EDINGER, Dist. Sanitary Engineer New York State Dept. of Health, 61 Albany Ave., Kingston

District	*Counties Included*	*Director*
Middletown..	Orange Rockland Sullivan	P. L. Brooks, Dist. Milk Sanitarian New York State Dept. of Health, 34 South St., Middletown
New York City	....	E. J. Buckley, Dist. Milk Sanitarian (District Director at Large) New York State Dept. of Health, 80 Centre St., New York City
	Nassau	F. M. Wales, Senior Milk Sanitarian Nassau County Dept. of Health, Mineola
	Suffolk	T. H. Ryan, Milk Inspector Suffolk County Dept. of Health, Riverhead
	Westchester	G. W. Molyneux, Chief Milk Sanitarian Westchester County Dept. of Health, White Plains
Oneonta......	Delaware Otsego Schoharie	P. A. Beckler, Dist. Milk Sanitarian New York State Dept. of Health, 16 Dietz St., Oneonta
Poughkeepsie.	Dutchess Putnam	P. W. Simson, Dist. Sanitary Engineer New York State Dept. of Health, 35 Market St., Poughkeepsie
Rochester....	Livingston Monroe Wayne	C. S. Springstead, Dist. Milk Sanitarian New York State Dept. of Health, 510 Terminal Bldg., Rochester
Saranac Lake.	Clinton Essex, Franklin Hamilton	J. A. Stalbird, Dist. Sanitary Engineer, New York State Dept. of Health, Paul Smith Bldg., Saranac Lake
Syracuse.....	Cayuga, Cortland Onondaga Oswego	E. P. Heffernan, Dist. Milk Sanitarian New York State Dept. of Health, 411 Herald Bldg., Syracuse
Utica........	Herkimer Madison Oneida	G. G. Kloser, Dist. Milk Sanitarian New York State Dept. of Health, 18 Pearl St., Utica

The work relates mostly to general preparations for emergencies and milk protection against sabotage involving the development of plans for protecting milk supplies and diverting them in time of emergency. This will be carried on by the State, District and Local Directors of Emergency Milk Supplies, generally outside the framework of the civilian protection organization at both State and local levels, except that the local Directors of Civilian Protection and the State War Council are kept advised as to the progress of work under this plan. However, the work under items 8, 9 and 10 of

the objectives listed above must be correlated closely with local control centers, in order that warnings of damages to milk pasteurizing plants and the water supplies, electric services and traffic arteries on which their operation depends will be transmitted immediately by telephone or messenger to the local Directors of Emergency Milk Supplies.

Survey. The State, District and Assistant District Directors of Emergency Milk Supplies in cooperation with local Directors will complete a study of milk pasteurizing plant facilities already under way and establish for use lists of key, secondary and suburban plants, with their normal and emergency capacities, together with notes covering special conditions favoring operation independent of public water and power supplies. This study is to be extended to include locating and making arrangements for the use of portable steam boilers, motor generator sets and milk trucks.

Volunteer Workers. There is no need for enlisting nor training volunteer plant workers. The increased need for operators in plants working longer hours to do work for crippled plants can be met by transferring operators from such crippled plants to the relief plants. If unexpected circumstances arise in which it should be necessary to have additional operators, such persons will have to be trained on short notice by the owner or other operators. The district directors are prepared to assist in such training if necessary.

Embargo. Chapter 500 of the laws of 1942, amending the Public Health Law, authorizes the State Commissioner of Health to embargo any part of a milk supply which in his opinion may have been contaminated. It is possible that saboteurs may attempt to contaminate cans or tanks of milk. Instances in which suspicious characters are caught tampering with milk containers should be reported promptly to the District Director of Emergency Milk Supplies, who shall immediately notify the State Director of Emergency Milk Supplies.

Employees. One of the duties of the State and District Directors of Emergency Milk Supplies is to assist milk plant operators in determining the loyalty to the United States of their employees, to advise the exclusion of visitors to plants, to encourage the adoption of employee identification systems in large plants and to advise that precautions be taken to protect milk from contamination while it is not under the immediate observation of trusted employees.

Blackouts. All night pasteurizing plants and particularly those designated as key plants, where night operation may be required in an

emergency, should be equipped for blackouts. Plans are to be developed and made available to assist plant operators in doing this work.

"Boil Milk" Warnings. Large supplies of milk bottle collars, containing a warning that the milk in the bottle is raw instead of pasteurized as labeled and should be boiled before using, are available at all twenty district offices of the State Department of Health. These collars may be obtained on short notice by telephone or messenger request to any District Director of Emergency Milk Supplies.

Copies of the leaflet as given below, describing a method of home pasteurization, are available to local Directors of Civilian Protection who may wish to have it reprinted for general distribution.

IMPORTANT PUBLIC NOTICE

EMERGENCY PASTEURIZATION OF MILK

Raw Milk Is Potentially Dangerous.

The one great reason for pasteurization is to destroy disease bacteria. In an emergency, milk can and should be pasteurized in the home or boiled. Boiling will accomplish the purpose equally well but will give the milk a cooked taste.

To Boil.

If you do not have a satisfactory thermometer, bring the milk to a boil in any clean cooking pot or pan and cool as rapidly as possible.

To Pasteurize.

1 Place cold or warm water in the bottom or outer section of a double boiler or other deep container.

2 Pour the raw milk in the inner section of the double boiler, put the inner section into the outer container and place over a burner. Do not apply direct heat to the milk.

3 Place a clean thermometer in the milk and stir gently and continuously with a clean spoon. Watch the thermometer and heat the milk quickly to at least 160 *Degrees Fahrenheit.*

4 As soon as the thermometer reads 160° F. remove the milk container and dump the hot water from the outer container.

5 Fill the outer section with cold water or ice in water and replace the inner section into the outer section in order to cool the milk rapidly to 50° F. or lower.

6 Place the cooled milk in the refrigerator. If the pasteurized milk is transferred to the raw milk bottle or to another container be absolutely sure to scald such bottle or container with boiling water.

If You Do Not Have a Satisfactory Thermometer, Do Not Guess at the Temperature: But Be Sure to Boil All Raw Milk Before It Is Used.

Bureau of Milk Sanitation

NEW YORK STATE DEPARTMENT OF HEALTH

Edward S. Godfrey, Jr., M. D., Commissioner

Milk for Evacuees. The State, District and Local Directors of Emergency Milk Supplies are to study plans for evacuation and reception of populations and to make necessary arrangements to divert milk on short notice from evacuation to billeting areas. It may be necessary to utilize for this purpose abandoned pasteurizing equipment in up-state receiving stations formerly operated as pasteurizing plants.

Warnings of Emergencies. It is important that the Mutual Aid Plan for Milk Service be coordinated closely with each local Control Center through the local Director of Civilian Protection. The efforts to prevent the interruption of milk services will depend largely upon the prompt notification by telephone to the local Director of Emergency Milk Supplies of all damages to milk pasteurizing plants and the public water supply and electric power service so necessary for their operation. It is also essential that such Director be notified of the closing of any main artery of traffic, in order that affected milk deliveries between farm and plant and between plant and consumer may promptly be rerouted.

PART II

ORGANIZATION AND TRAINING OF WATER MAIN EMERGENCY REPAIR CREWS AND AUXILIARY PERSONNEL ASSIGNED TO EMERGENCY WATER SERVICE DUTIES

Purpose of Part II.

Part II is supplementary to the general "Manual of Emergency Sanitation Services" issued by the State Water Supply Coordinator of the State Office of Civilian Protection. In Part I will be found a rather complete discussion of the preparation of water supplies for emergencies, a detailed explanation of the New York State Mutual Aid Plan for Water Service, the specific objectives of this plan in relation to the fields of general preparations and civilian protection, an explanation of the Division of Water Main Emergency Repairs and its functions in the field of civilian protection (organization, development and training of water main emergency repair crews, etc.), the integration of water departments under local Directors of Civilian Protection as parts of the local civilian protection organizations, and technical information related to the proper solution of emergency water supply problems.

This bulletin is designed to serve as a guide to local Directors of Civilian Protection and local water officials in the organization, development and training of auxiliary or volunteer emergency water main repair crews and other auxiliary personnel assigned to emergency water service duties. It will repeat only the materials included in the manual which are pertinent to the above purpose, but will expand on the outline of the training courses in such a way that this bulletin can be used as a syllabus and training guide for the courses to be given to auxiliary or volunteer water service personnel by the local water officials.

The matter of organizing and training a sufficient number of water main emergency repair crews in each municipality of the State is urgent if we are to be adequately prepared to meet any emergencies. Local Directors of Civilian Protection and local water authorities are therefore to proceed with the organization and training of such crews and other needed reserve or auxiliary personnel in accordance with the suggestions and recommendations made in this bulletin. Zone and Assistant Zone Coordinators should be called upon to give assistance in the training program.

Chapter I. Integration of Local Water Department in the Local Civilian Protection Organization

In all matters related to the field of civilian protection which includes the organization, development and training of water main emergency repair crews and other auxiliary personnel for emerengcy water service duties, the local Director of Civilian Protection is in general command. It is his duty to see that such crews and auxiliary personnel are organized and adequately trained, but he will delegate to the local water officials the detailed responsibilities for their development, training, disposition, and assignment.

The State Water Supply Coordinator acts as technical advisor to the State Director of Civilian Protection. Zone and Assistant Zone Water Supply Coordinators act as technical advisors to the local Directors of Civilian Protection, and local water officials on all matters related to water. In this field of civilian protection, involving as it does all of the arrangements for establishment of an emergency organization of the water department to effect water main repairs and meet other water service problems promptly in the event of an emergency, the entire Mutual Aid Water Plan administrative organization operates as a Division of Water Main Emergency Repairs under the State Director of Civilian Protection.

In a similar way at the local level the local water head or person in responsible charge of the water supply serves as technical advisor to the local Directors of Civilian Protection on all water matters and is the directive authority of such local Directors in relation to all emergency water service matters. The local water official in an emergency will utilize regular water department personnel to perform and direct the functions of emergency repairs and maintenance.

With reference to emergency repair of water mains and other emergency water service duties he will, on behalf of the local Director of Civilian Protection have such auxiliary or volunteer personnel as are necessary under the local circumstances enrolled and directed to these protective services by the local civilian mobilization representative. Standards for such enrollees as formulated by the State Water Supply Coordinator and issued to the State Director of Civilian Mobilization are given below.

It is the duty of the local water department head to formulate plans for the organization and training of all auxiliary or volunteer personnel who are to perform water service duties in the event of an emergency and to furnish copies thereof to Zone and Assistant

Zone Water Supply Coordinators. It is also the duty of the local water department head to conduct or cooperate with other water superintendents in the county in conducting such training courses according to the course of instruction outlined in this bulletin.

In the larger communities all emergency utility services may be grouped under the general command of the local Director of Civilian Protection, in which case the local water department head will be his technical advisor and person responsible for preparation and execution of plans, organization, training and assignment. In smaller communities and in some other instances, the local water department head may be appointed to serve as a member of the local Civilian Protection Director's staff.

Responsibilities of Local Water Authorities.

Local water officials are clearly responsible for the management and operation of public water supplies. These responsibilities are inherent and cannot be shifted from the water officials to anyone else. If a catastrophe occurs it will be the local water officials and no one else who will have to take the blame for shortcomings of any kind, irrespective of the attempts which may have been made to delegate responsibilities to others. These responsibilities, therefore, should be clearly recognized by local Directors of Civilian Protection and freely assumed by water officials.

In relation to the whole field of protective services as applied to water supply operation and maintenance, emergency repairs, etc., the local water officials have the sole responsibilities and must make the decisions on all matters related to the supply of water in the community. They must assume the responsibilities for the work of all regular and auxiliary personnel assigned to emergency water service duties and must suffer no interference from other elements of the local civilian protection organization on matters that clearly fall within the scope of their responsibilities.

Clear recognition of these principles by both local Directors of Civilian Protection and local water authorities will contribute to the most efficient functioning of the water department as a unit in the local civilian protection organization and to the kind of relationships which must be established to assure teamwork and fullest cooperation.

Control Center Liaison with Water Department.

In event of a serious bombing, extent of the disruption of water service will be the primary factor governing the degree of the catastrophe. If water fails all else fails. Without water, fire departments will be unable to control fires and the catastrophe will run its natural course. The difference of a few minutes in closing valves to stop the loss of water at a break may mean all the difference in the world in diminishing the extent of the catastrophe.

It is therefore of utmost importance that adequate arrangements be set up in the control or report center of each community so that water officials will receive immediate reports of air raid alert signals and prompt reports of water incidents relayed to the control center by air raid wardens. It is important that water officials be notified of air raid warning signals, etc., as promptly as such warnings are made to fire officials. The water department should be apprised of all "yellow" air raid alert signals as well as "red" signals, so that it can place all of its personnel in readiness for instant action in case an actual air raid occurs.

A representative of the water department should be in attendance at the control center at all times, responsible for the relaying of messages to the water official. In the control center there should be complete plans of all the water mains in the area (skeleton plans are good enough), with sizes and valve positions prominently marked, together with "key" industries, charts and names and addresses and telephone numbers of all personnel likely to be needed in an emergency, together with similar data concerning the key men of other adjoining water authorities and their control services. The key industries should be informed if any incident occurs affecting their supplies. Standby messenger service should be available in case telephone lines are out of order.

Air raid wardens in making reports of water incidents should state the exact position of the incident, the time of origin, whether inside or outside of premises, other services affected, whether the break appears large or small, obstructions, and such other helpful information as it is possible for them to obtain quickly. These reports should be made to the control center as quickly as possible and be relayed immediately to the local responsible water official, whose duty it is to get one of his employees to the scene immediately to shut off valves, to prevent loss of water, to make an estimate of the repair jobs and to arrange for repairs as speedily as possible.

It is the duty of local water officials to see that proper arrangements are worked out with local Directors of Civilian Protection for their representation at control centers.

Recruitment of Auxiliary or Volunteer Personnel.

For his emergency organization, the local water official shall utilize such of his regular employees as are suitable and competent to serve as foremen of water main emergency repair crews or in other key emergency capacities. All volunteer personnel, to the extent required by the local water department head to complete his emergency organization in accordance with the instructions contained in this bulletin, shall be enrolled with and assigned to water service duties by the local civilian mobilization representative. This includes all volunteer personnel previously enlisted directly by local water officials, if they are not now enrolled. To complete the records of the Volunteer Mobilization Branch, the record cards of all personnel previously enlisted shall be turned over to that branch for recording and filing.

Local water officials should therefore consult with the local civilian mobilization representative and arrange to have assigned to them such volunteer personnel as are required for emergency water service duties under the particular local circumstances.

Chapter II. Qualifications of Volunteer Personnel Assigned to Emergency Water Service Duties

The State Water Supply Coordinator has notified the State Director of Civilian Mobilization that the following qualifications are required of all volunteer personnel enrolled for emergency water service duties:

Foremen of Water Main Emergency Repair Crews.

a Persons who are licensed to practice as master plumbers; or

b Journeymen or apprentice plumbers who are recommended by their employers as competent to supervise water main repairs after some training and under supervision of the water superintendents; or

c Persons with previous experience as steamfitters or in laying or repair of water, oil, gas, steam or other pipe lines; or

d Other persons with qualifications acceptable to the local water superintendent. The local water service authority shall accept only such individuals to serve as foremen and water main emergency repair crews as in his opinion have the necessary qualifications.

Members of Water Main Emergency Repair Crews. Robust physical condition with preferably previous experience in ditching or excavation work, ability to handle heavy pipe and perform hard manual labor, and handy with the pick, shovel and other ordinary tools.

Turncocks or Valve Operators. Same general qualifications as for foremen of water main emergency crews. (Generally the foremen of water main repair crews would perform the functions of shutting off water and making quick estimates of repair jobs following reports of broken water mains or other water incidents.)

Supervisors of Emergency Water Delivery Service Organization. At least a high school graduate, with some knowledge of chemistry and practical experience in the direction of a small group of workmen. Must be intelligent and have ability to learn the fundamentals of handling water and of disinfecting water and equipment after a short course of training.

Operators of Temporary or Auxiliary Chlorination Plants. Persons with previous experience in operation of mechanical equipment such as pumps, motors, chemical feeders, refrigeration or other small machines. Must be sufficiently intelligent to master the fundamentals of water treatment after a short course of training.

Chapter III. Extent of Auxiliary or Volunteer Personnel Required

Standards for Personnel.

The State Water Supply Coordinator has established the following standards which are subject to increase if future experience indicates the need therefor. As a start, local water departments in all communities should proceed to organize and train repair crews and other auxiliary water service workers in accordance with the following.

Water Main Emergency Repair Crews.

a Each crew shall consist of a foreman and six members, provided, however, that the local water official may increase or decrease the number of members of each crew as he may deem advisable.

b Each crew shall be supplied or have access to the supplies, tools and equipment needed for repair jobs. (See Part I, Chapter V, for a list of recommended repair equipment and supplies.)

c In communities *which are in or within 10 miles of what are considered to be by the local Directors of Civilian Protection likely target areas* the number of water main emergency crews which should be organized, trained, and developed are indicated in the following table:

Municipalities: Population Range	*No. of Emergency Repair Crews Needed*
Less than 2,000	1
2,000 to 5,000	2
5,000 to 9,000	3
9,000 to 14,000	4
14,000 to 20,000	5
20,000 to 28,000	6
28,000 to 34,000	7
34,000 to 42,000	8
42,000 to 49,000	9
49,000 to 75,000	10 to 12
75,000 to 100,000	12 to 15
100,000 to 200,000	15 to 24
200,000 to 300,000	24 to 32
300,000 to 400,000	32 to 40
400,000 to 500,000	40 to 48
500,000 to 600,000	48 to 54

d In communities *which are considered by local directors to be from 10 to 20 miles from likely target areas* emergency water main repair crews in the ratio of at least 50% of those indicated above should be organized and trained.

e In communities *which are considered by local directors to be well removed from likely target areas* at least one such emergency repair crew should be organized and trained in each community under 5,000, at least 2 in communities between 5,000 and 20,000, and at least 3 in communities above 20,000.

The above rules relating to the number of emergency repair crews which should be organized and trained are based upon the principle that proceeding outward from the most likely target areas the need for such repair crews as applying to each particular area will diminish but that in all areas, whether deemed subject to possible attack or not, there should be a sufficient number of repair crews to constitute a reserve for quick assignment to areas under attack where additional crews from outside areas undoubtedly will be needed.

Under the theory of mutual assistance, the small isolated community which would be given prompt aid in the event of difficulties of any kind is obligated to make some contribution to the general cause. The organization and training of emergency repair crews to at least the extent indicated above affords one opportunity for the small communities to make a definite and valuable contribution, not only in the interest of self protection but to the general plan of mutual assistance.

Turncocks or Valve Operators. Either the foreman of each emergency water main repair crew should serve in this capacity or valve operators should be organized and trained in the ratio of one to each emergency water main repair crew.

Supervisors of Emergency Water Delivery Service Organization. One such organization should be established and a supervisor appointed and trained in each community of the State, regardless of size, if the community is considered by the local director to be in or within 10 miles of a likely target area. The extent of the organization will vary with the local circumstances but should be sufficient to adequately handle the emergency delivery of water to residents in the event of a complete water failure. Plans for such organization should be worked out by the local water officials in cooperation with the local health officer and the local director.

Operators of Temporary or Auxiliary Water Treatment Plants. In each community three such operators should be appointed and trained for each emergency water supply which it is locally anticipated may have to be utilized by direct pumping into the system.

Training.

The training courses for the auxiliaries should be administered by the local water department heads or by superintendents, utilizing the services of regular employees or others who are competent to give instruction on particular subjects. The content of the training program is suggested in the syllabus contained in this bulletin.

In the small isolated communities well removed from likely target areas, where the auxiliaries to be trained may be limited to one or two persons, the training course should be conducted largely by the conference method unless several communities combine to give a joint course. In that case, the auxiliaries of several communities can be brought together for training in those subjects which have general application. On subjects which have strictly local application, however, each local water superintendent will have to give the instruction.

In general, it is recommended that water officials in large cities conduct training courses exclusively for their own auxiliaries, but that joint or combined courses be established to provide training for auxiliaries in the smaller cities, villages and town water districts. These joint or combined courses should be encouraged by County Directors of Civilian Protection and organized on a county basis so far as possible. The suggested syllabus for the training program is based upon a class of from a half dozen to about 30 auxiliaries. It should be given to all auxiliaries who are to serve as foremen of water main emergency repair crews, turncocks or valve operators, supervisors of emergency water delivery services, or operators of emergency pumping stations and chlorination plants, with attendance required at class sessions by the various auxiliaries as indicated in the syllabus.

It is not contemplated that labor members of repair crews shall complete the entire course of instruction. They should be invited to attend any or all of the classes and required to attend those which have specific application to their emergency duties. They should be required to take part in all drills and field tests which, upon completion of the course, should be repeated from time to time, to sustain interest and develop perfection in the emergency organization.

The training course for all auxiliaries in the classes mentioned above shall include 30 hours of actual instruction, at least 20 hours of which shall be classroom instruction. Up to 10 hours of actual field drill or practice may be counted as part of the required total of 30 hours instruction.

It is recommended that 2-hour classes be held twice each week until each auxiliary has completed 20 hours of classroom work, and that the classroom instruction then be followed as soon as possible by 5 two-hour periods of field work. However, it may prove more advantageous to alternate field lessons and class lessons.

Upon completion of the prescribed course of training the local water official shall certify the names of those whom he regards as having satisfactorily passed the course to the State Water Supply Coordinator through the Zone Coordinator. The State Water Supply Coordinator will certify all such names referred to him to the Office of War Training of the State War Council, which Office will arrange to issue certificates to those whose names have been so certified.

The local Directors of Civilian Protection should arrange to issue or authorize the issuance of appropriate arm bands or other insignia as are approved by the State Director of Civilian Protection, to all auxiliary or volunteer personnel assigned to emergency water service duties upon recommendation of the local water official. It is important that all auxiliaries, including labor members of repair crews, be issued arm bands with approved insigne, so that no difficulties will be encountered by them in reporting to their stations or performing their duties during air raid alarms or actual emergencies.

Instructional Methods.

Each instructor should attempt to develop as much as possible the attitude of a school teacher in preparing for and in conducting the training classes. He should make the instruction formal to the extent of being well prepared for the lectures and demonstrations he is to give and the problems he is to solve, but informal to the extent that he will command the attention of his students and secure their free participation in discussion.

The classroom preferably should be a quiet room in a water plant, shop, or perhaps a local school, with sufficient chairs and other furniture to make the students comfortable and give them the feeling that they are actually in school. A black board should be available and used frequently to illustrate particularly important points in the instruction. Visual instruction aids should be used wherever possible, as they are particularly helpful in getting the instruction across to the student. Wherever actual demonstrations of making repairs, making orthotolidine tests, etc., can be made, they should be employed; and the students should be given an opportunity to repeat the demonstrations themselves. Motion pictures to illustrate

London air raids and other features of a blitzkreig, particularly if they relate to water, should be used. These are obtainable through the Office of War Training, 353 Broadway, Albany.

It is obvious that to maintain interest and attention in the classroom the local water superintendent who is to conduct the classroom session should be well prepared in advance of the lesson and know exactly what he is to cover and what he is to do. Otherwise, instruction will lag and students will lose interest.

The course offered herein is intended only as a guide and may be modified to suit local requirements as long as equivalent instruction on the subjects indicated is provided.

* Teaching Hints in the Training of Water Department Auxiliaries.

Step 1. Preparation.

A *By the Water Department Instructor*

1 Determine what you are going to teach.

- *a* Decide what material you are going to cover.
- *b* Determine the principal points in each lesson.
- *c* Arrange the material in the order in which you wish to cover it.
- *d* Find out the principal points in your lesson involving
  - (1) things auxiliaries must be able to do, such as disinfecting mains, repairing pipes, etc.
  - (2) information which auxiliaries must be able to apply, such as orthotolidine tests, etc.

2 Plan each lesson

- *a* Keep on the track.
- *b* Eliminate unrelated material which will only confuse the auxiliary.
- *c* Build up the principal points logically.
- *d* Plan in detail how you will
  - (1) demonstrate the things the auxiliaries must be able to do.
  - (2) teach the information which auxiliaries must be able to apply.
- *e* Check your delivery and time yourself in a practice session before each lesson.

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* See the Appendix for more detailed and general outline, "Suggestions for Starting and Conducting a Class."

3 Set your stage.

a Have enough seats available.

b Have plenty of light and air in the classroom.

c Have a blackboard .

d Have motion picture and slide projection machines where possible.

e Have ready all tools and other pieces of equipment you may need.

f Have demonstration equipment and tools arranged in the order in which you will use them.

B Of the Auxiliary

1 Put the auxiliary at his ease. Be friendly, but let auxiliaries know they are subject to department discipline.

2 Get the auxiliary interested in learning what you are going to teach him.

3 Point out how it will benefit him, his family and his friends to learn the information which you are going to present.

Step 2. Presentation.

A General Procedure

1 Tell the auxiliary plainly and simply what the lesson covers.

2 Avoid the use of technical language wherever possible. Talk plainly and simply.

3 Dramatize the material by presenting stories from your own experience. Keep on the point with such stories.

4 Show the auxiliary the things about which you are talking.

5 Illustrate their use or importance.

6 Question the auxiliary to be sure he understands.

B Things to Keep in Mind

1 Stress principal points. Do not take the punch out of your lesson by stressing equally both important and unimportant points.

2 Be clear and complete about each point. Do not take up more than one point at a time. Do not take up a new idea before the auxiliary understands the old one.

3 Continue to check the auxiliary's grasp of each point by asking questions. Repeat statements and demonstrations when necessary.

4 Convey to the auxiliary the importance of each new point you raise. For example, tell how failure to chlorinate may result in an epidemic.

5 Use moving pictures, slides, diagrams and drawings where possible. Be sure to explain clearly all important points.

Step 3. Performance.

A When the auxiliary is learning how to do things, teach him by having him perform the job. Have him operate repair equipment, etc.

B When the auxiliary is being given general or technical information, question him on his understanding of it. Ask the auxiliary to apply his new knowledge in an imaginary situation. Check carefully on the understanding shown by his answer.

Step 4. Checking.

A Carefully check the auxiliary's performance or statements.

B Ask questions beginning with why, how, who, what, where and when.

C Don't start new lesson material until you are sure the auxiliary has mastered the previous lesson.

D At intervals review not only the previous lesson but all the preceding lessons.

* Syllabus Outline of Instruction

Class Training Sessions

Class Training Session	*Subject*	*Attendance Required of*	*Combined or Separate Class*
1......	Organization and operation of local water department and the water supply	All auxiliaries	Separate
2......	Relation of water to health	All auxiliaries	Combined
3......	Relation of water supply to fire protection	All auxiliaries	Combined
4......	Chlorination and tests for residual chlorine	All auxiliaries	Combined
5......	Disinfection of water pipes, water handling equipment, tanks and reservoirs	All auxiliaries	Combined
6......	General repair technics	All auxiliaries	Combined
7......	Temporary repair of broken water lines	Foremen of repair crews. Attendance optional for others	Combined
8......	Use and operation of repair equipment	Foremen of repair crews. Attendance optional for others	Separate
9......	Location and operation of valves and fire hydrants	Foremen of repair crews. Attendance optional for others	Separate
10......	Operation of chlorinators and handling of chlorine	Supervisors of emergency water delivery services and emergency pumping plant or treatment plant operators. Attendance optional for others	Combined
11......	Operation of pumps	Supervisors of emergency water delivery services and emergency pumping plant or treatment plant operators. Attendance optional for others	Combined
12......	Emergency sources of water supply	Supervisors of emergency water delivery services and emergency pumping plant or treatment plant operators. Attendance optional for others	Separate
13......	Plans of action in case of emergencies	All auxiliaries	Separate

* *A detailed syllabus for each training session will be found at head of each lesson in Part III.*

FIELD TRAINING SESSIONS

Field Training Sessions	*Demonstration*	*Attendance Required of*	*Combined or Separate Class*
1.......	Operation of a fire pumper	All auxiliaries	Combined
2.......	Inspection of a water purification plant	All auxiliaries	Combined
3.......	Inspection and operation of local repair and maintenance equipment	All auxiliaries	Separate
4.......	Practice in chlorine demand and residual tests and batch disinfection of water	Supervisors of emergency water delivery services and emergency pumping station and treatment plant operators. Attendance optional for others	Combined
5.......	Practice in making repairs or operating repair equipment	Foremen of repair crews	Separate
6.......	*Drill under simulated emergency conditions	All auxiliaries	Separate

* *Lesson No. 6* should be repeated from time to time under different simulated emergencies in accordance with the plans of action worked out by the local water officials. Laborers assigned to repair crews should participate in all field drills.

In each class or field period lectures should be adjusted to allow for discussion periods, oral quizzes, etc.

It is suggested that at the last class lesson a brief examination of the "true-false" type be given to all auxiliaries, the questions being adapted for the type of service the various auxiliaries are to perform.

The following outline of class and field lessons should prove helpful to instructors in developing the course of instruction. It is not intended to be complete, since local water superintendents and others who are to serve as instructors are expected to exercise ingenuity in planning the course to fit the local needs and circumstances. Variations in the course content, inclusion of additional subjects, and rearrangement of the order of lessons should be made if this seems desirable in the judgment of those responsible for conducting the courses.

Field lesson No. 6 should not be regarded as the final lesson of the course, except in relation to obtaining Certificates of Completion. Field lesson No. 6 should be repeated from time to time under different simulated emergency conditions, to give auxiliaries the practice which they need and to develop perfection in the emergency organization and plans for action. In such drills, to the fullest possible extent, there should be actual assembly and transportation to the point of need of material and equipment, and thorough discussion of the simulated problems and how they are to be handled.

Sequence of Events in Case of Actual Bombing.

In order to help water officials visualize what they may be called upon to face, provided an actual air raid occurs at night and damage to the water system results, the following imaginary sequence has been set up:

1. Yellow Warning signal received by local control center from District Warning Center.
2. Water superintendent is alerted and calls key men to station.
3. Air raid siren sounds and other water department employees go to predetermined point or stay at home awaiting call.
4. The air raid.
5. Bomb damages water main.
6. Control center is advised of damage by police, air raid wardens or others.
7. Control center notifies water department headquarters.
8. Water department headquarters orders crew to shut off damaged main.
9. Shut off crew cuts off water main.
10. Shut off crew notifies department headquarters, using preferential telephone, that work of shutting off has been completed.
11. Water department headquarters notifies control center and through them, the fire department, that main is out of service.
12. Superintendent or foreman inspects site of bombing.
13. Plans are made and crews organized for performing the necessary repair work.
14. If repair work appears to be beyond ability of local department to cope with, the Zone Coordinator is called on for aid.
15. Repair work is started at daylight, unless the main damaged is one that cannot be kept out of service or unless blackout is over before morning.

In arranging drill periods (Field Lesson No. 6), the plans should be developed to synchronize activities along the lines of the anticipated sequence of events.

Following completion of the above course of instruction the auxiliaries should be brought together from time to time and given supplementary information concerning emergency problems, etc. In this connection planned meetings, at which motion pictures illustrative of emergency water problems and duties would be shown, will do much to sustain interest of the auxiliaries in their work and emergency assignments.

PART III

PROGRAM FOR THE ORGANIZATION AND TRAINING OF WATER WORKS AUXILIARIES

This program is described and the general pattern is discussed in Part I *"Organization and Training of Water Main Emergency Repair Crews and Auxiliary Personnel Assigned to Emergency Water Service Duties."*

All local water officials have an important part to play in this program and it is important that they have a thorough understanding of its purposes, objectives and details. Toward this end the following questions and answers have been formulated. It is hoped that careful study of the bulletin mentioned above, together with the following questions and answers, will contribute to a clear understanding of the program and the detailed role which the local water officials are to play in it.

Questions and Answers to Help Acquaint Local Water Officials with Details of the Program

What are local water officials expected to do about organizing and training emergency Water Works Auxiliaries?

It is the responsibility of all local water officials to see to it that a sufficient number of auxiliaries in all classes of water service are recruited, organized and trained so that an adequate number of trained personnel will be available to meet any kind of a water emergency.

What are local Directors of Civilian Protection expected to do about this program?

To see to it that all local water officials fully meet the above responsibilities.

Does the program apply to water officials in small as well as in large communities?

Yes. It is essential that all water officials cooperate 100% in the program.

Why is this program essential?

For many good reasons. We are advised by our military authorities that no community can justifiably consider itself as immune to bombing, fifth column or sabotage attack. There-

fore all communities should be prepared to the fullest possible extent to handle serious water emergencies.

No community, if it suffers a severe attack is likely to have sufficient trained personnel including trained auxiliaries available to meet the needs. Therefore, there must be a reservoir of trained personnel throughout the State from which large numbers of trained men may be drawn for assignment on emergency work in stricken areas.

The program to be fully effective requires the momentum engendered through 100% cooperation from all local water authorities. Non-cooperation from a few communities acts as a brake on the whole effort.

Maintenance of the water supply in any community constitutes one of the vital keystones of civilian protection. If water fails, almost everything else may fail. Water officials are completely responsible for maintenance of the water supply in their communities under any possible conditions. They have been given a program to develop and place in effective operation as a part of the National and State and Local plans for civilian protection. It behooves all water officials to participate wholeheartedly and realistically in this program, if not out of fear of possible bombing attacks, then out of patriotic impulses and the desire to make the maximum possible contribution to the war effort.

We cannot afford to be ill-prepared for the unforeseeable events which lie before us. Therefore, anything less than total effort in the direction of adequate preparation for emergencies will be insufficient.

Finally, the water works fraternity has been given a tremendous job to do. You are looked upon as competent to do the job and must not fail in the performance of the vital duties which quite frankly are imposed upon you. Aside from the recognition which you will get for a job well done and for the protection of lives and property to which you are making an important contribution, your cooperation in the program should produce a wholesome respect by the general public and the officials of other civilian protection services for the role being played in our civilian protection plans by the water works fraternity.

Into what classes are water service auxiliaries divided?

Foremen of water main emergency repair crews, valve operators (unless the functions of valve operators are to be

performed by foremen of repair crews), supervisors of emergency water delivery services, emergency pumping station or treatment plant operators, and labor members of repair crews or emergency water delivery service organizations.

What are the functions of the foremen of emergency repair crews?

To take charge of repair crews under general direction of the local water superintendent, and effect prompt repairs of broken water mains, and perform related work in the event of emergency.

What are the functions of supervisors of emergency water delivery services?

In the event of a serious water failure and the need to provide for door-to-door delivery of water in tank trucks, etc., to take charge of such operations under supervision of the local water officials and the local health authorities.

What are the functions of valve operators?

Unless these functions are to be performed by foremen of emergency repair crews, to immediately shut off water on either side of pipe breaks following reported "water incidents," but under general direction of the local water official.

What are the functions of emergency pumping station or treatment plant operators?

Under direction of the local water officials, to operate pumping stations or treatment plants established upon emergency sources of water supply.

What are the functions of labor members of repair crews, etc?

Under direction of the foremen, etc., to perform the manual work required on repair jobs, etc.

How many auxiliaries in each class of service should be recruited, organized and trained in each community of the State?

This is answered under *"Organization and Training of Water Main Emergency Repair Crews and Auxiliary Personnel."* The numbers given therein are to be taken as the minimum. Whenever possible the number should be increased and all communities should be considered as in or within ten miles

of a possible target area, since no community can justly consider itself immune from attacks.

The minimum number of foremen which should be provided may be computed by the following formula: (Take the nearest whole number)

$N = .05\,P + \sqrt{P}$, where

N = number of foremen to be organized and trained

P = population of the municipality divided by 1000.

Each community, particularly those regarded as in or within likely target areas, should provide at least one trained supervisor of emergency water delivery services.

Each community should provide and train three emergency pumping station or treatment plant operators for each emergency water supply which it is anticipated may have to be utilized by pumping into the system.

Valve operators (unless their functions are to be exercised by foremen) should be provided and trained in the ratio of one to each emergency foreman.

Labor members of crews should be provided in such numbers as may be stipulated by the local water official. (Generally 3 to 6)

How are these auxiliaries to be recruited?

Through the Volunteer Offices which are attached to each local War Council and which operate under the State Director of Civilian Mobilization.

What is the procedure for securing the assignment of auxiliaries to you for training and assignment to your emergency organization?

Notify the local Volunteer Office of your local War Council as to the exact number and class of auxiliaries which you need. It is the responsibility of these offices to see that such auxiliaries are recruited and assigned to you and that all of them have qualifications as prescribed by the State Water Supply Coordinator.

Should water works officials attempt to recruit their own auxiliaries?

Yes, by all means, but be sure to have the auxiliaries properly registered by the Volunteer Office. It will be of considerable help to the Volunteer Offices if local water officials will direct prospective water service auxiliaries to the Volunteer Offices for registration.

Should water officials rely on members of their regular organization to serve in special emergency capacities?

Yes! It is desirable that full use be made of all existing or regular employees who are capable of being trained for special emergency duties in any of the classes of service. Labor members of regular repair crews, etc., should be given special training so as to fit them to serve as foremen, etc. After you have exhausted the possibilities of utilizing regular employees for your emergency organization, then you should ask the local Volunteer Office for volunteer auxiliaries.

Should all auxiliaries, including regular employees who are to be assigned to emergency duties, be given special training?

Yes, any person who is to be assigned to special emergency duties in any of the classes of water service should be thoroughly trained in such duties.

Are all auxiliaries to be given the same course of training?

Not exactly. Auxiliaries are to be given special training related to the particular emergency duties they are to perform. Some of the instruction will be the same for all auxiliaries, but certain lessons will apply to auxiliaries in a particular class of service. That is, foremen of repair crews will be required to take certain lessons not required of auxiliary treatment plant operators and vice-versa. Labor members of crews, etc., are not required to take the Water Works Auxiliaries Training Course but should naturally participate in all drills, etc.

What is the Water Works Auxiliaries Training Course?

The standard course of training prescribed by the State Water Supply Coordinator to be given to all auxiliaries or persons assigned to emergency water service duties, except labor members of repair crews, etc.

What is the nature of this course?

It consists of 13 class lessons and 6 field lessons, supplemented by drills following completion of the course. Each lesson, both class and field, is to embrace about 2 hours of instruction in the practical fundamentals of each subject. The syllabus of this course is given in *"Organization and Training of Water Main Emergency Repair Crews and Auxiliary Personnel"*.

Do all auxiliaries have to take the full course of 13 class lessons and 6 field lessons?

Each auxiliary is to take the 10 class lessons and 5 field lessons prescribed for the particular class of service to which he is assigned.

What lessons of the course are prescribed for foremen of repair crews and valve operators?

Class Lessons No. 1, 2, 3, 4, 5, 6, 7, 8, 9, and 13 and Field Lessons No. 1, 2, 3, 5 and 6. These lessons cover the subjects which have particular application to the duties which foremen and valve operators are to perform.

What lessons of the course are prescribed for supervisors of emergency water delivery services and auxiliary pumping station and treatment plant operators?

Class Lessons No. 1, 2, 3, 4, 5, 6, 10, 11, 12 and 13 and Field Lessons No. 1, 2, 3, 4 and 6. These lessons cover the subjects which have particular application to the duties which supervisors and treatment plant operators are to perform.

Can auxiliaries be excused from some of the lessons?

No, unless the particular auxiliary is certified by the local water official as already having an adequate knowledge of the particular subject covered by the particular lesson. For example, an auxiliary who is known by the local water superintendent to be particularly skilled in the operation and care of pumps could be excused from taking class lesson No. 11 which relates to this subject. However, in general all auxiliaries should take the full prescribed course of 20 hours of class and 10 hours of field instruction. Even for experienced and well trained men, the course will serve as a "refresher" and it is desirable for them to take the full course.

What credit will auxiliaries receive upon completion of the course?

All will receive appropriate certificates to be issued by the Office of War Training of the State War Council.

In addition, all auxiliaries who satisfactorily complete the lessons prescribed for supervisors of emergency treatment plant operators will be credited with having met the special course requirements prescribed under the State Sanitary Code for Grade III water treatment plant operator; and if they have had

3 months of satisfactory operating experience in a water plant or satisfactory equivalent experience, they will be eligible for a certificate of qualification as a Grade III water treatment plant operator.

Who is to give this course of instruction to auxiliaries?

The local water superintendent will have to give some of the lessons separately to his own auxiliaries. These are the lessons which have specific local application and which cannot be taught to combined groups of auxiliaries from several localities. However, so far as possible combined classes will be organized in each county and instruction given on the lessons which have general application by instructors to be selected by the Zone Water Supply Coordinator. It will be the latter's responsibility to organize and develop these courses in each county or at central locations, so as to be as accessible as possible to auxiliaries from the various communities of each county. Such courses may be given at one central location or the school may be rotated among several communities under such arrangement as may be decided upon locally.

In some instances, however, if an auxiliary misses some of the lessons it will be necessary for the local water superintendent to give such lessons separately to his own auxiliaries.

War Training Committees of local War Councils help to coordinate all civilian war training. They should be called upon to help with instructor-training, providing films and other instructional materials.

What particular lessons are local water superintendents expected to give separately to their own auxiliaries?

Class Lesson No. 1—"Organization and operation of the local water department and the water supply."

Class Lesson No. 8—"Use and operation of repair equipment"—unless the Zone Coordinator arranges to include this lesson in the combined class. In general it will be desirable for this subject to be taught in a combined class in view of the small amount of repair equipment in some of the smaller water departments.

Class Lesson No. 9—"Location and operation of valves and fire hydrants."

Class Lesson No. 12—"Emergency sources of water supply."

Class Lesson No. 13—"Plans of action in case of emergency."

Field Lesson No. 3—"Inspection and operation of local repair and maintenance of equipment."

Field Lesson No. 5—"Practice in making repairs or operation of repair equipment"—unless the Zone Coordinator arranges for this in the combined classes.

Field Lesson No. 6—"Drill under simulated emergency conditions." Note: This lesson is to be repeated from time to time after the auxiliaries have completed the course.

Can there be variations from the prescribed course of instruction?

Yes, if in the judgment of the Zone Coordinator and local water officials this seems desirable. The end objective is the important thing—to assure that all auxiliaries are given proper training for their emergency duties. But the training to be given the auxiliaries should be the full equivalent of that prescribed in the standard course. Any variations from the standard course should be designed to improve the course of training.

When are the Water Works Auxiliaries Training Courses to be started?

As soon as the Zone Coordinator with the assistance of local water officials can set them up and after the auxiliaries have been recruited and assigned. This should be done as soon as possible.

Should local water superintendents proceed now with the training of auxiliaries before the county classes are established?

Yes, if you have your auxiliaries lined up, instruction on the class lessons having specific local application should be undertaken as soon as possible.

What are the logical steps which all local water officials should take now in relation to participation in this program for the organization and training of water works auxiliaries?

First, determine the number of auxiliaries you will need and secure their recruitment and assignment to your emergency organization.

Second, proceed with the instruction of the auxiliaries in those subjects which have specific local application and for which the local water superintendent is responsible.

Third, cooperate with the Zone Coordinator in the establishment of the combined classes and arrange to have your auxiliaries attend these classes.

Fourth, when an auxiliary has satisfactorily completed the training course, certify the name of such auxiliary to the Zone Coordinator so that award of certificates can be made.

Fifth, after completion of the course, continue from time to time with drills, etc. and supplementary meetings with auxiliaries to sustain their interest.

What assurance is there that auxiliaries, once they are recruited and assigned, will attend the classes?

If the auxiliary has the right attitude he will make strenuous efforts to attend all of the classes. However, local water superintendents should make it as easy as possible for his auxiliaries to attend. Therefore, it is suggested that so far as possible local water superintendents arrange to attend all of the classes themselves and arrange for the transportation of their own auxiliaries to these classes.

If an auxiliary does not have the right attitude, there is not much use of continuing him as an auxiliary and you should seek to recruit a substitute in his place.

Do auxiliaries have to complete the course before they are given arm bands, etc.?

No. Water Department employees and auxiliaries should be provided as soon as possible with necessary insignia to enable them to get to their stations through blackouts. The matter of insignia should be taken up with your local Directors of Civilian Protection. It is not required that auxiliaries take the course of instruction prior to issuance of arm band insignia.

What other award is given to those satisfactorily completing the training course?

Regents Training certificates issued by the University of the State of New York through its Bureau of Public Service Training.

CLASS LESSON NO. I

Organization and Operation of the Local Water Department

NOTE: For illustrative purposes, the Wellsville Water Department is used here as an example. Each community will naturally use its own local water department as the instructional example.

SYLLABUS FOR CLASS TRAINING SESSION NO. 1

2 Hours

Subject. Organization and operation of the local water department and water supply.

Instructor. Each local water department head should give this lesson separately to his own auxiliaries.

Scope. *First hour:* Lecture covering history and development of local water supply, organization of water department, rules and regulations in effect, description of supply with explanation of the functions of various elements, etc. Use map of water system, pertinent charts and blackboard sketches to illustrate particular features.

Second hour: Discussion period and oral quiz followed by demonstration of how to solve simple arithmetical problems involving ratios, percentages, calculation of volumes of water in pipes, reservoirs, excavations, etc. Problems should be selected which will be typical of those likely to be encountered in making repair estimates, etc.

Assign for study prior to lesson No. 2 pages 188 to 202 of Bulletin No. 22 of New York State Department of Health entitled "Water Supply Control." This assignment relates to conversion factors and the arithmetic of water treatment.

Reference Text for Lesson.

A historical review of the development of the local water supply should start with the original construction during the year of 1883. The original water works was constructed at that time by private interests called the Wellsville Water Company.

The original source of supply was a storage reservoir constructed

entirely of earth embankments having an area of approximately one and three quarters (1¾) acres that acted as a catchment basin on a small stream, which during periods of low rainfall was practically devoid of water. The supply was later supplemented by a series of dug wells on the banks of the Genesee River and one deep well. This latter source proved to be unsuited for the purpose, being heavily charged with iron, sulphur and very hard. The unsatisfactory supply and rates charged was the subject of considerable controversy between the local authorities and the company officials, and created a desire to operate the property as a municipal project.

In 1915 a committee of citizens of Wellsville was appointed by the Board of Trustees to investigate the water supply situation and make recommendations as to the best solution, insofar as the interests of the village were concerned.

As a result of the report of the Committee, it was decided to purchase the entire interests of the private company and to reconstruct and supplement the original system. Carrying out the recommendations of the committee, the property of the Wellsville Water Company and Wellsville Electric Light and Power Company was purchased in 1915.

Immediately after their acquisition the properties were expanded, improved and many additions constructed. A part of this program consisted of constructing a slow sand filter plant on a high hill approximately one mile, by travel distance, from the pumping station having a capacity of ¾ million gallons per day. This source of supply was water taken from the Genesee River.

The Genesee River water is not adapted for slow sand filtration without preliminary chemical treatment, being highly turbid, high in color and containing silt in excess of the ability of any economical retention period to remove. Briefly stated, the plant did not seem to be adapted to the type of water to be treated and the climatic conditions under which it expected to render service.

Due to mechanical, hydraulic and construction troubles, this slow sand filter had to be abandoned. Severe leakage developed in several of the structures embraced within the slow sand filter plant amounting to approximately 125,000,000 gallons per year, which was equivalent to approximately 30% of the total pumpage. The slow sand filter plant was constructed at an elevation of approximately 260 feet above the pumping station. Pumping this amount of water, that was loss by leakage plus the amount needed for backwashing the filters, proved to be an expensive operation.

The mathematics of the power wasted in pumping this amount

of water against such a head may be interesting, revealing why the slow sand filter was abandoned, and such subject will be treated in another paper.

A rapid sand filter plant, together with additional pumping facilities, was constructed during 1921 adjacent to the pumping and electric generating station. The filter plant and generating plant being housed under one roof tended to simplify the operation of both units and materially reduced the cost of operation. The settling basin used in connection with the slow sand filters was repaired and used as a floating storage reservoir. With minor exceptions, this is the system now in use to supply both fire protection and water for domestic use.

Summary of System.

A water supply system may be best described by first dividing it into its several component parts, such as collection or source, transmission, treatment, storage and distribution. The mechanical and hydraulic features of the local supply can be briefly summarized as follows:

Collection and Source. Concrete intake dam in the Genesee River which acts as a small retaining reservoir and intake for the untreated water. This is jointly owned by the Village and the Sinclair Refining Company.

Transmission. A 16″ wood stave pipe line carries the supply from the intake dam to a receiving well adjacent to the filter plant.

Treatment. Two low lift centrifugal pumps, electrically driven, with a capacity of one million gallons a day each, force the water from the receiving well into the sedimentation basin being treated with coagulating chemicals while passing through the pumps. Flow from the sedimentation basin into the filters by gravity through a twelve inch cast iron pipe. Directly under the filters is a filtered water basin, capacity 28,000 gallons, in which the water is treated with chlorine and soda ash, thence pumped by a one million gallon a day, centrifugal electric driven pump into the distribution system.

The filter plant has three filter beds having a combined capacity of one million gallons per day. Reserve, or standby high duty pumping capacity is furnished by one electric driven centrifugal 1¾ million gallon pump located in adjacent generating station. Auxiliary, for emergency conditions only, source of raw or untreated water can be made available by using the pumping equipment operated

in connection with the condensers of the steam turbines. The back washing of the filters is accomplished by using an electric driven centrifugal pump capable of supplying 1750 gallons per minute.

The characteristics of a centrifugal pump are predetermined by the design. The design controls, at a given speed, the effective head and quantity. Advantage can be taken of this feature when pumping into an open structure to prevent an overflow or wastage.

Whenever the total head reaches a predetermined point or value the capacity and available pressure will rapidly decrease to a point of non-effectiveness. This proves valuable in the instance of the local supply, providing means of pumping direct into the distribution system, with inlet valves to the storage closed without creating an excessive pressure on the system.

Storage. Storage is provided by a 3 million gallon concrete storage reservoir which was originally constructed to serve as a settling basin for the slow sand filters and whose elevation is approximately 260 feet above the pumping station. This storage reservoir floats on the distribution system and absorbs the excess pumpage over consumption during pumping periods and provides adequate fire protection and domestic use.

Distribution System. The distribution system consists of the following approximate quantities, etc: Water mains 4-14″–20.73 miles; Hydrants, 158; Valves, 220.

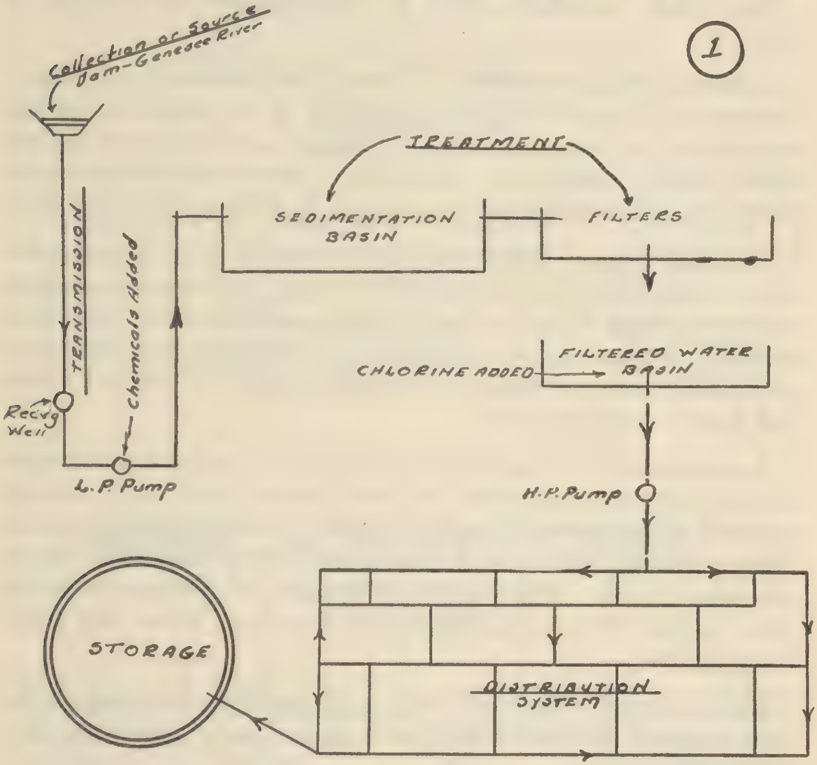
The above enumerated do not include house connections or services numbering approximately 1250 serving 1600 meters and 70 flat rate accounts. The distribution system supplies water to a number of factories and other large consumers such as the Moore Steam Turbine Company, who require approximately 15% of the entire plant output to fulfill its needs, also the Erie Railroad, Baltimore & Ohio Railroad and others. (See Figure 1).

Organization.

At the time the purchase of the properties was consummated the Board of Trustees, acting under the provisions of the Village Law, Section 222, appointed a Board of Water and Light Commissioners consisting of five members, to operate, supervise and manage the combined properties. The system has remained under the control of a board of this nature to date. The Board of Water and Light Commissioners are considered as the administrative body, with the Superintendent an executive to place into effect their policies. This

method of control of utilities tends to encourage and prompt long term planning and policies.

Whenever a municipal utility is operated by a Board of Commissioners, the Village Law provides that they shall have the power to employ, fix compensation and define the duties of all employees.



DIAGRAMATIC SKETCH OF LOCAL WATER SYSTEM

The local condition is such that the Board acts upon the recommendation of the Superintendent relative to such matters.

The Superintendent supervises the purchase of all current supplies, materials and engages all emergency labor. Unusual expenditures and/or what might be called "luxury" purchases are referred to the Board for approval prior to placing orders. The Superintendent directs the labors of all employees, defines working hours, plans and designs all extensions to the systems and supervises the conduct of all affairs in connection with the operation of both units.

The employees of the system are as follows: Assistant Superintendent, Office Manager, Accountant, Line Foreman, Mechanic, Boiler Room Operator, Operators, Firemen, Line Men, Cashier, Billing Machine Operator, Meter Reader, Meter Tester, Chemist, Storekeeper and Laborers.

The duties assigned to some of the employees are outlined as follows:

Assistant Superintendent. During the absence of the Superintendent will have charge of the affairs of the system, maintain the outside distribution system, set meters, test meters, inspect and repair hydrants and direct the activities of the laborers employed under him. Also supervises the making of all taps and connections.

Office Manager. Under the general direction of the Superintendent, he has charge of the commercial office and the employees engaged therein, including the meter readers, clerks, cashier and billing machine operator. Supervision over consumer accounts, billing and collections, all financial books and records and acting clerk to the Board of Water and Light Commissioners.

Accountant. Purchasing of all supplies and materials are handled by the Accountant; maintains all work orders, meter, materials and supplies and property records; prepares entries for the general ledger accounts, exclusive of consumer accounts and maintains station operating records. The Accountant prepares all invoices for audit, prior to their being presented to the Board of Water and Light Commissioners.

Line Foreman. He is in charge of all outside construction for the electric system and electric equipment repairs in the generating plant and pumping stations.

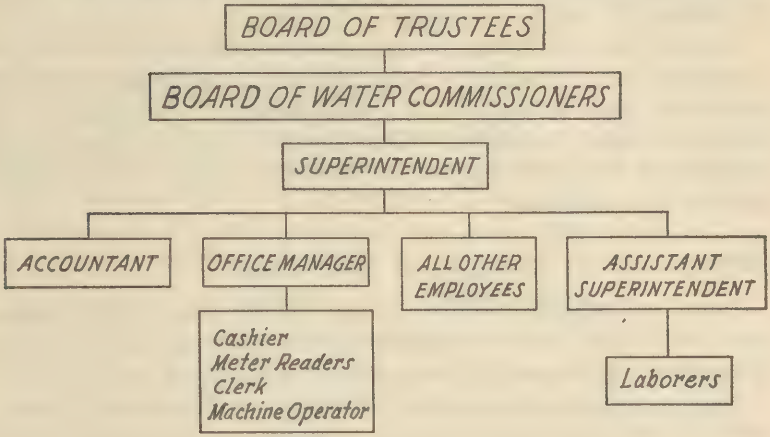
Chemist and Storekeeper. Duties are divided between the water works laboratory, maintaining operating records of the water treatment plant and stores and materials accounting.

Other Employees. Assume duties that are described by the title of position. (See accompanying charts)

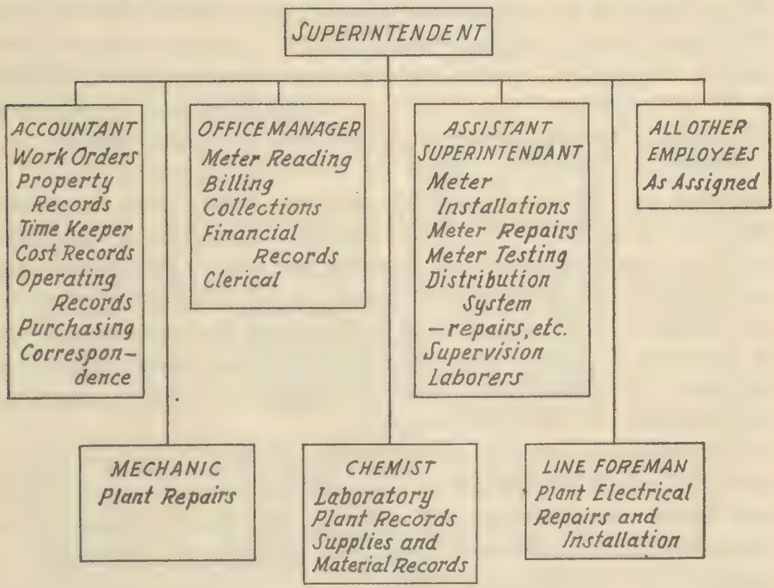
It has been noted that the combined operation of two different utilities offers opportunities to effect economies by doubling duties of employees. Classes of employees enumerated include many that would not be normally employed by a municipal water system.

The accounting practices employed by the local system indicate the exact division of labor and material costs between the two depart-

LOCAL WATER DEPARTMENT
TYPICAL ORGANIZATION CHART



WORK ROUTINE CHART



ments, or units. Electric energy used in connection with the operation of the water supply system is accurately metered and purchased from the electric department at practically cost. Labor and materials are allocated on basis of use, thereby maintaining an accurate record of costs at all times.

The electric generating station operators also act as filter plant operators, their labor costs being divided in accordance with the amount of time devoted to the individual unit. The wages of the Superintendent, Accountant, Chemist and others engaged in the operation of both units are likewise divided in proportion to the value of services performed.

Patrol and Protection of Watershed.

Rules and regulations of the State Health Department, enacted into law, require that the local authorities insure sanitary conditions throughout the watershed from which the supply is taken.

This watershed embraces over 200 square miles of land, some of which is practically inaccessible to all mankind and animals, except perhaps a mountain goat. Close cooperation with the members of the local Rod and Gun Club and others interested in wild life and conservation has proved to be of great value in protecting the watershed from violation of the above mentioned rules and regulations.

The doctors, health officers, hospitals and others have been helpful in reporting the appearance of contagious diseases in the territory contributory to the water supply. Whenever water-borne disease is reported on the watershed, prompt inspection is made of the premises and steps taken to insure disinfection of materials which might have a detrimental effect upon the water supply.

During the period in which the slow sand filter plant was in operation an outbreak of typhoid occurred. There were seven cases resulting in three deaths in two families. Inspection revealed that generous quantities of excreta, bedding and other objectionable matter had been dumped into a stream of water flowing into the local water supply. The method used to chlorinate the water supply was, in the opinion of the Superintendent, far from being effective at the time. It caused many anxious moments for those responsible for the safety of the water supply.

Whenever possible, it is better to forestall such conditions than to try to overcome their effects after something has happened. Sportsmen fishing along streams will penetrate into the far reaches of the watershed which otherwise would be difficult and expensive for agents of the water supply to visit.

The cooperation between the sportsmen and the local authorities has resulted in obtaining valued information relative to the existence of dead wild and domestic animals along the banks and beds of streams constituting the water supply. This is information that otherwise would be difficult and expensive to obtain.

Local Rules and Regulations.

Section 228 of the Village Law grants authority to the Board of Water and Light Commissioners to prescribe rules and regulations for the enforcement of collection and use of water. Pursuant to this authority, local rules and regulations have been adopted that will be summarized as follows:

1 Cites the Law authorizing the adoption of rules, etc.
2 Definition of terms used in rules, etc.
3 Provides that written application for service must be filed.
4 Service and meter location must be approved by an agent of the Board.
5 Written notice to connect service to water mains.
6 Property owner must protect curbstops and boxes.
7 Leaks in service lines, on property side, must be repaired by property owner.
8 Agents shall have access to premises during reasonable hours.
9 Property owner shall make provision for meter installation and protect same. Meters sealed by agents of water board. Section provides for action in event of tampering.
10 Control of Curb Cock.
11 Meter tests; Public Service Commission standard for testing meters adopted.
12 Meter reading; provides estimating amount used when necessary.
13 Liability for bills; makes the property owner responsible for all water service bills regardless of who the consumer may be. Unpaid bills are added to Tax Rolls.
14 Payment of bills, date and condition of payment of all bills.
15 Resumption of service after discontinuing for breach of contract, etc.
16 No liability for failure of service, shutting off or restricting service.
17 Service interference, property owner's equipment must not interfere with service to others.
18 Changes in rules and regulations.

19 Filing and changes to water tariff.

20 Amendments, etc.

All provisions stated above are incorporated into *an application for service* which must be signed and sworn to by the property owner, thereby becoming a contract.

The property owner has the privilege of requesting that bills for water service be sent to, and paid by tenant, but this request does not relieve the property of responsibility should the tenant fail to meet his obligations.

Care and Maintenance of Distribution System.

It is the general practice to have all hydrants inspected at least twice a year. This inspection includes examination of stems, caps, greasing and oiling, examination for leakage and flushing. The Assistant Superintendent and Laborers make this inspection during various periods of sufficient frequency to insure a complete coverage of the system. Main gates, or valves and their attendant valve boxes are inspected at the same time inspection is made of hydrants.

During the period of inspection of hydrants, a leak detector is applied to the stem or cap of each hydrant to check the distribution system for leakage. Certain types of leak detectors are sensitive enough to indicate a small leak at considerable distance along the main water lines. Often valuable information is gained by this method, revealing unsuspected wastage of water by leaks that otherwise would be undetected. Meter readers report any evidence of leaks in service that can be heard at/or near the meters.

It is unfortunate the main gates or valves were not standardized as to the operating characteristics; that is, some open by turning to the left, others open by turning in the opposite direction. An attempt to overcome this confusion has been made by painting the inside of all valve boxes with a distinguishing color. Red paint was used to indicate valve opening to the left. This paint was applied rather liberally to both the inside of the cover and the box itself. Any box devoid of paint is assumed to open turning clockwise. All maps showing the location of valves, etc., are marked with a distinguishing symbol to indicate its operating characteristics.

One source of trouble and constant annoyance is dirt, sticks and stones lodged in curb shut-off boxes. No satisfactory solution of this trouble has been found. It requires constant vigilance to keep this part of a distribution system in good working condition. Whenever the shut-off projects above the surrounding lawn, people will try to drive it down, while others will try various methods of cover-

ing it. Shut-offs located in driveways are pounded down below the ground or drive level by the weight of cars. Whenever occasion demands prompt action in closing the curb shut-off, invariably that particular box is full of material covering the key, and the water officials are blamed for failing to comply with the wishes of the waiting property owner.

Constant inspection of a distribution system is necessary to prevent concealing of main gate box by the other agencies of the municipality. Street repair gangs seem to consider the water works valves an unnecessary evil and give precedence to the appearance and riding qualities of the street surface.

Prior to any street improvement project, all main gate boxes and curb shut-offs are marked in a conspicuous manner and a frequent check is made to insure that they are not disturbed during the period of construction.

Meter Reading, Etc.

The Wellsville Water System should not be considered as a typical municipal system, due to the combined operation of two difficult utilities by one force. It has been stated that the system of accounting employed makes possible an accurate cost record of each unit.

Electric light and power meters are read every month, while the water meters are read every three months. Two meter readers are normally employed for the combined readings. It is estimated that one meter reader will read approximately 160 meters a day. Routes for the meter readers are laid out to insure a minimum travel to cover a maximum area. Each meter reading slip number corresponds with the consumer ledger account.

Advantage is taken of the "machine age" by using a modern bookkeeping machine. Previous and present meter readings, water consumed, gross and net amount of bill together with delinquent account, if any, are entered simultaneously on consumer's ledger sheet and previously addressed bill. Operator of billing machine is able to bill approximately 90 accounts per hour. Payments on accounts are posted directly to the consumer's ledger sheet by the same machine. All water bills are required to be paid by the twentieth of the month following the rendering of the bill. Enforcement of collections is provided by the contract adopted as previously noted. Unpaid accounts are reported to the tax collector for collection as taxes.

Property and General Ledger Accounting.

The Accountant prepares each month, a statement giving in detail the proper respective entries to be made by the Office Manager on

the property and general ledgers. This statement contains detailed information relevant to labor, materials and supply costs distributed between capital and operating accounts. The Office Manager submits a monthly statement of receipts and expenditures for the information of the Superintendent and Board of Water Commissioners. A comparative balance sheet or report is prepared at the end of each quarter, giving in detail all assets, liabilities, cash statement, comparative accounts receivable, etc. The comparison is between previous and corresponding quarters, as well as the previous year. This report contains an analysis of various accounts, such as delinquent accounts, cash, income and operating expenses, etc.

Maps and Records.

Man's memory often fails at critical times. The operation of a water supply must be carried on regardless of wind, storms or floods and the fading of man's memory. The practice of trusting to any man's memory the essential details of a water supply system cannot be condemned too severely.

A water works operator can be judged by the character of maps and records maintained of the system under his jurisdiction. The system employed by the local water works to record all phases of underground structures and operating details will be described.

Whenever any type of construction is in progress which tends to uncover or expose underground structures of any nature, the character, size, purpose and location of the same is made a matter of permanent record. This includes gas, sewer, oil, electric conduits, telephone conduits and water lines. This data is entered into surveyor's notebooks and filed until such time as sufficient information has accumulated to justify entering on a detail plan.

The first essential of successful mapping of underground structures is to be sure that permanent bench or land marks are chosen as reference points. Small trees, poles and semi-permanent structures are not recommended, due to the possibility of their location being changed. The masonry foundations, hydrants, established curb lines, retaining walls, permanent sidewalk lines, catch basin inlets and other similar objects may be used as permanent reference points. The moving or relocation of any of the above mentioned permanent reference points can be readily detected and records changed to correspond to the new location.

Some of the general and detail maps and records maintained by the local water works are: 300 feet to inch general water system

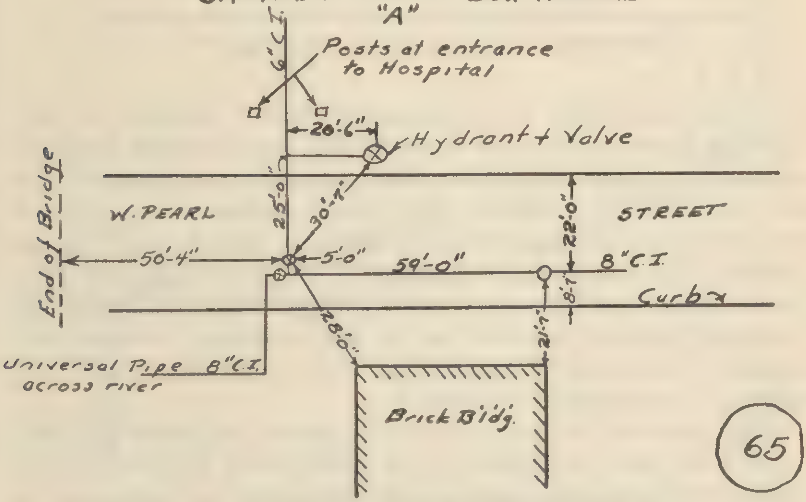
distribution map. This map shows the various sizes, classes and types of materials incorporated into the distribution system and key numbers indicating the number of page in the valve books on which detailed references are shown to indicate the location of all main gates or valves. This map is revised approximately every three years. One copy, called the working copy, is printed on white paper mounted on cloth permitting pencil notes, corrections and alterations to be made as necessary. These pencil notes are transferred to the original tracing upon revision of same.

The general information shown on the 300 feet to one inch map is further enlarged and drawn on 17 sheets twenty-two by twenty-six inches having a scale of 150 feet to the inch. These sheets contain all the detailed information available relevant to the underground system. The enlarged scale and available space permits a mass of essential information to be incorporated as a permanent record.

Detailed references to valve locations are made on 5½ by 8 inch tracings, each being numbered to correspond with the key number of 300 feet to an inch larger distribution map. Copies of each tracing are filed in a number of loose leaf books and used for all field work. These books are kept in each of the service trucks and copies supplied to key employees. (See Example "A" below.)

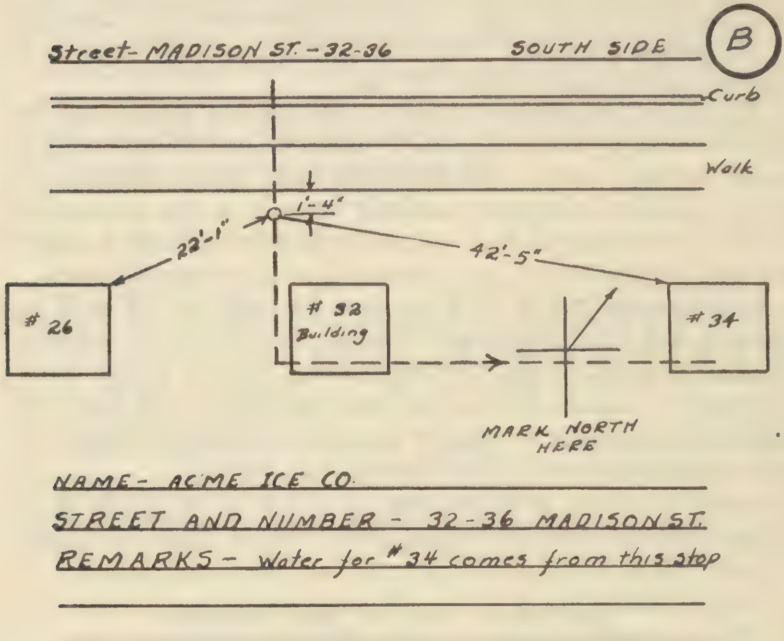
Curb shut-offs or cocks as located are recorded on 5½ by 8 inch cards; the stock used in printing these cards is extra heavy paper

SAMPLE VALVE BOX RECORD
"A"



PEARL ST. AT BRIDGE + HOSPITAL SER

and filed according to street numbers. Every house and vacant lot is represented by a card. It is a relatively simple task to determine the lack of information by having a card for every possible location. Whenever additional information is secured, it is entered on the proper card. (See Example "B" below.)



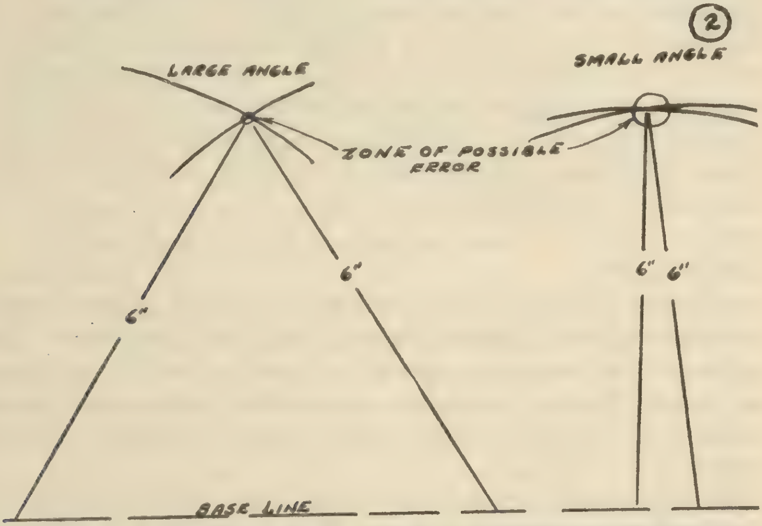
SAMPLE CURB BOX RECORD

A standard system of recording the data of locations of curb shut-offs is used; that is, all measurements are taken and drawn to represent its respective position while a person is standing with his back to the front of the house. Make sketch showing that the angle at the apex of a triangle, having unequal sides, should be as large as possible; this is important to avoid error. A small angle will introduce a greater possibility of error than a larger angle. A tape held at one point and a circle marked on the earth surface at the given distance is to be crossed by a similar line drawn from another point and distance. (See Figures 2 and 2A.)

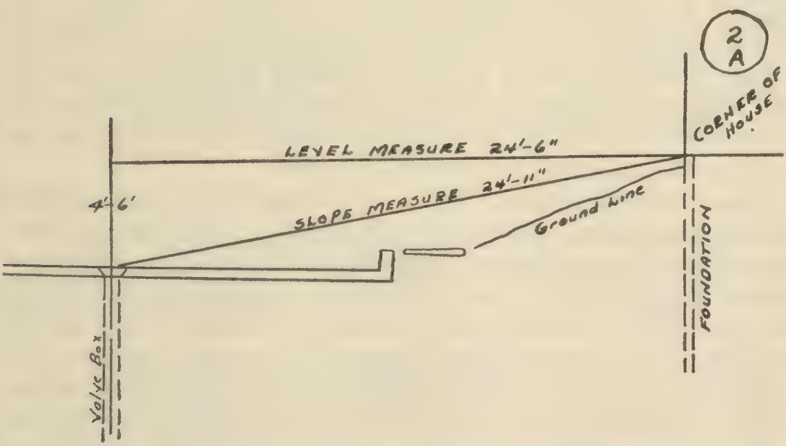
Detail maps of various streets are maintained that show data relevant to the depth and station of all underground structures. This information is usually given on individual sheets for each street or section thereof, and the scale used is usually 50 feet to one inch.

Summary

General Distribution System.	One Map—300 feet to one inch
Detail Distribution Record...	17 Sheets—150 feet to one inch
Valve Locations............	68 Sheets—5½ x 8″ No scale
Curb Box Locations........	1400 Cards 5½x8″
Miscellaneous Data.........	17 Surveyor's Field Books



ILLUSTRATING POSSIBLE ERROR IN MEASUREMENTS DUE TO ANGLE AT APEX OF TRIANGLE



ILLUSTRATING DIFFERENCE BETWEEN SLOPE AND LEVEL MEASURE

An established practice of the local water works is thought to be worthy of recommendation. That practice requires the storage of copies of all records at more than one point. Whenever tracings, or original drawings or records are kept in the operating office, a copy of the same is placed for safe keeping in a fireproof vault in the Municipal Building. This is done to make it remotely impossible that all records will be destroyed during any one disaster.

Another practice that has been adopted is to take advantage of the simplicity and low cost of making photographic copies of all records. Photographs are taken on 35 mm film of all curb box location cards, valve location tracings and similar records. The negative is always stored in a different location from the originals. It is relatively inexpensive and requires but a short time to make available copies of the originals.

Graphs, Etc.

Tabulated statistics are dull, uninteresting and it is often difficult to realize or draw a mental picture of their full significance. Any person who can use a pen or pencil and draw a straight line on paper can develop the true significance of quantities and the trend of any phase of operation of a water supply system by using a series of graphs.

The local water works operators develop statistics pertaining to its operation to the fullest extent. One great value of graphs is that they readily indicate the general trend of any quantity or phase of operation. Assume that a graph, illustrating the amount of water pumped covering an extensive period, is kept up to date. Any decided change in the characteristics of the graph line, indicating the amount of water pumped, will reveal seasonal variation of consumption, leakage, increased, decreased, or unaccounted for; and on the other hand will prove the value of work towards eliminating leakage by showing a corresponding drop in the curve.

Should the amount pumped be plotted against the time required, the efficiency of pumps, etc., can be checked. Some of the most common graphs used at the local plant are: Gallons pumped plotted against time; electrical energy used and total pressure checking the efficiency of pumping units; percentage of wash water against total filtered as a check of the efficiency of chemical treatment and settling basins; gallons of water filtered per filter against time, another overall check of treatment efficiency; chemicals applied against one million gallons; million of gallons against labor costs and many others.

Miscellaneous Information and Instructions.

Standard gate valves require the following number of turns to open the limit of utmost travel for respective sizes: 2″—7 turns; 4″—9 turns; 6″—21 turns; 8″—27 turns; 10″—33 turns; and 12″—39 turns. Valve Box and covers marked with red paint. Valve will open by turning counterclockwise or to the left. All other valves must be operated by turning clockwise to open. Whenever a valve is operated, whether opened or closed, report the position of the valve to the operating office.

Always open a valve to its utmost limit of travel. Never leave a valve box open or uncovered without stationing an employee in the vicinity. Extreme care should be exercised in opening any valve, large or small. Be sure that the connecting piping is in condition to receive the charge of water and the movement of the valve MUST be very slow.

Whenever filling a water line that has been drained provide some means whereby the entrapped air can be removed slowly before the maximum pressure is built up. If there is a hydrant in the section that has been closed off, it can be opened to release the air. It may be necessary to provide vents in the plumbing of a house.

Open valve very slowly until the rush of water begins to be heard, then wait until this sound subsides. Continue to open valve slowly until it reaches its position of utmost travel—replace valve box cover. Should the valve appear to leak around the stem after closing, apply some strain to the valve key. The maximum strain, for valves under 10″, should not exceed that possible to apply by one good strong man. If the valve continues to blow around the stem, close for two or three turns and then re-open to the limit of travel. Provided the valve continues to leak, it should be reported as leaking.

Hydrants.

The local supply has installed in its distribution lines two general classes of hydrants; i.e., Compression and Wedge Gate. These distinctions are not technically correct but will serve the purpose at this time.

The Darling, Corey, Mathews and Kennedy Hydrants are classed as compression types and the Ludlow as a wedge gate type for the purposes of this paper.

All compression type hydrants are relatively easy to operate. The usual two foot hydrant wrench will exert sufficient leverage for one

man to operate same. Do not use any leverage longer than provided by the hydrant wrench. Should the hydrant show evidence of leaking after the valve is seated, open three or four turns and close again. This will assist in clearing the seat of any grit, gravel or other foreign material which may have lodged between seat and valve.

The wedge type of hydrant, especially so of the older type installed in the local supply, require materially more effort on the operator's part to open and close. Do not increase the leverage, but call assistance of another man. Excessive leverage in closing the valve often springs the gate and stem and increases rather than lessens the possibility of leakage. Should the hydrant show signs of leakage past the valve, slowly open the valve one or two turns. If this fails to correct condition, report it as defective.

All hydrants are equipped with a drain valve in the bottom of the barrel. This valve automatically opens as the main valve is closed. The purpose of this drain is to permit the water entrapped in the barrel to escape below the frost line. While the hydrant main valve is being opened, the drain valve will remain open until several turns of the stem have been made. Therefore, be sure to open the main valve to its extreme position.

Whenever a hydrant has been in service, be certain that the drain valve in the bottom is open. Proof of its being open is to watch the water level in the barrel. When the drain functions properly, the water in the barrel will quickly disappear. Tie a weight of any kind securely to a piece of string and lower same into barrel to the bottom. The string should show signs of being submerged in water, if water is standing in the barrel. *Caution: Be sure that the weight is fastened securely to the string and that it is removed from the hydrant!*

A hydrant cap can be replaced by hand, provided the threads, etc., are in good condition. The threads are purposely made a loose fit. Nozzles are caulked into the barrel with lead and will not resist any great twisting strain. *Don't* force the cap onto the nozzle. Use the hydrant wrench and the strength of but one arm.

Avoid excessive strains and pressures on the hydrants and distribution system by closing the hydrants very slowly. Tremendous pressures will be built throughout the distribution system by the sudden closure of valves and hydrants. Water is incompressible and the sudden stoppage of any stream of water will exert high pressures in all directions. The faster the stream is moving, the greater the disruptive force created. *Play Safe! Go Slow.*

All hydrants open by turning in a counter-clockwise direction; that is, to the left.

Curb Shut-Offs, Etc.

Before turning on the water in a house that has been vacant or unoccupied for some time, be sure that some responsible member of the family is present. Numerous cases of trouble have been experienced due to unprepared condition of inside plumbing and damage to the property has resulted from not observing this requirement. Whenever possible, notify the occupant of premises before shutting off water, thereby preventing any possibility of complaints. Curb shut-offs are right angle valves; that is, require but one quarter of a turn to shut tight.

Chlorine Equipment.

Do not handle chlorine drums or make repairs to chlorine equipment unless standby assistance is available. Should an extreme emergency demand prompt action, without such aid, be sure that all doors and windows are wide open. Stand on the wind side of the equipment, even when using a mask. Have necessary tools and repair parts handy and towards the draft through the building. Check equipment every day for leakage.

Electrical and Mechanical Equipment in Filter Plant.

The High Pressure and Wash Water Pumps located in the pump room of the filter plant are operated by high tension current and must be regarded dangerous at all times. Don't attempt to make any adjustments to control, switching and/or wiring in connection with these pumps unless the safety cutout disconnects in meter room are open. Be sure that *you* know they are open! Don't take anybody's word for this. See for yourself. The balance of the electrical equipment used in the filter plant is called 'low tension' but is unsafe to work around without disconnecting the switches feeding it, due to the damp condition of floors, etc.

Do not attempt to run any pump unless it has been properly primed or filled with water. Running a pump while empty will cause rapid wear of moving parts and packing. Means to prime and exhaust the air from each unit is provided. Indicators are available to inform operators when the pumps, etc., are properly primed and ready to put into operation. Be sure to watch these indicators.

Overload safety devices are provided to protect all units from dan-

gerous overload conditions. Don't lock, block or attempt to adjust them. Let the electrician make all changes and adjustments.

Provided the source of power fails, all valves leading from the filters, EFFLUENT, must be closed at once. Otherwise a dangerous flooding of the pump room floor may occur.

The first duty of all operators is to locate and determine the use of all safety disconnecting switches throughout the plant and their position upon assuming duty.

Emergency Repairs, Etc.

The first step is to make a careful survey of the site and determine the extent of damage. The procedure or action that follows must, necessarily, be governed by the possible danger the break or leak may cause. Is the loss of water small or large? Is it endangering adjacent property? Does the leaking water flow off in well defined channels? Will continued flow result in injury to street surfaces? Whenever the loss of water is considered as being of paramount importance, all valves controlling that section should be closed promptly, without delaying to notify the consumers.

It should be borne in mind that all key industries should be notified of any reduction in service, whenever it is possible. The key industries are listed below:

> Moore Steam Turbine Company; Air Preheater Company; Sinclair Refining Company; Rockwell Bros. (Sprinkler); Scoville, Brown and Co. (Sprinkler); Public Library; Public Hospital; Disposal Plant; All Schools; Incinerator Plant; Burial Case Company.

When making the first survey of the site, attempt to determine the necessary equipment, labor and materials needed to effect repairs and check inventory to insure the availability of sufficient repair parts. This is especially important whenever the use of repair materials, such as assembled repair sleeves are to be used; that is, of the Dresser Coupling type, as one eighth inch may mean the difference between a slip and drive fit. *Remember that it is very important that precise determination of sizes be made.* Whenever the loss of water is not too great, direct employees to notify all consumers that the supply will be shut off for a certain period.

Provision for contingencies should be made by allowing double the time you think will be necessary. When handling smaller leaks, etc., have all equipment, materials and labor assembled prior to closing controlling valves. Assemble means to provide protection

to property and persons at the site and maintain same until the conclusion of all repairs and replacements of street surfaces, etc.

Protective devices and lighting are provided on each truck and full use of them should be made. They won't do any good stored in a truck.

The first employee reporting at the site of a serious break, one which will prevent proper use of the street, will remain stationed at the site to guard same.

Do not isolate a larger section of the distribution system than is absolutely necessary to control the flow.

Air Raid Instructions.

The following instructions are issued to create an organization to safeguard the property under the jurisdiction of the Board of Water and Light Commissioners.

It is essential that each and every employee have *a thorough understanding of his duties during a blackout,* to avoid confusion and delay. Every employee will be required to read these instructions carefully and become thoroughly familiar with his duties during an emergency.

During periods of air raid warnings every employee, whether on duty or off, will be required to report to his appointed station without delay and remain stationed until excused by leading employee present.

Don't leave personal cars in front drive at plant. Keep this drive free and clear at all times. Park along the curb in the street or in space used for parking in rear of plant.

Employees without telephone service must make arrangements whereby they can be notified of any warning or emergency.

Don't gather in groups around the plant. Stay away from the other fellow. Injuries to a group are liable to cripple the operating force. Should an accident occur let the employee at that point handle it, unless directed to assist.

Don't play flash lights around, keep the beam of light as near the floor as possible, *never* towards a window or skylight.

Each employee on taking station will be sure that the outside door nearest him is unlocked and free to open. Be sure that the floor area around your station is free of all movable obstructions.

Upon the receipt of the first air raid warning the following procedure is outlined as a guide to action:

Operator on Watch: Start air compressor, keep it running. Direct watchman to attend to telephone.

Watchman on Duty: Unlock gate, front and office doors. Answer telephone until relieved, then take station.

Fireman on Watch: Unlock fireroom doors.

Employees No. 1, No. 3 & No. 4: Lay out 2" fire hose and small hose with nozzles attached, then take stations.

Operators and Firemen off Duty: Assist in laying out hose and ladders to roofs, then take stations.

Employees No. 7 & No. 8: Report in Commercial Office and stand by.

Employes No. 5, No. 6 & No. 9: Move cars out of garage, separate as much as possible. Put ladders on building, take stations.

Employee No. 2: Stand by in front office.

The responsibility of operating the lighting control panels is assigned to employees as given below. Be sure that you know the panel assigned you and the lights which it controls. *Don't pull main switches of these panels,* pull the individual switches, to prevent flashes and burning of contact points, etc.

The following panels are to be operated during a *blackout* period: Panel "A"—Turbine Room; Panel "AA"—St. Light Room; Panel "B" Boiler Room; Panel "C"—Filter Room; Panel "D"—Meter Room; Panel "E"—Store Room. **Don't pull individual switches marked with red paint.**

The assignment of employees to the above panels are as follows: Panel "A" and "AA"—Employee No. 2 or Operator on watch; Panel "B"—Employee No. 4 or fireman on watch; Panel "C"—Employee No. 3 or standby employee; Panel "D"— Employee No. 1 or standby employee; Panel "E"—Employee No. 1 or standby employee.

The Designation of Employees as "Standby" are as Follows:— Employee No. 1—One operator off duty and one fireman off duty; Employee No. 2—Operator on Watch; Employee No. 3—One operator off duty; Employee No. 4—Fireman on watch and one fireman off duty. All other employees not specifically assigned will report to Employee No. 1 in shop.

Upon Receipt of Actual Raid Warning: Signal for Blackout

Employee No. 1 or any employee in *Shop*. Blows air siren, short blasts
Employee No. 2 or Operator on watch... Cuts off street lights.
Assigned Employees.................. Turns off plant lights.

Stations of Employees During Plant Blackout: Employee No. 1, station in *shop* in position to watch both turbine and filter rooms. Be sure that back door is unlocked. Be ready to lead fire hose in any direction. Call Operator on watch or standby employee to turn on

water when needed. Employee No. 2, station at main switchboard. Unlock door near Kerr Turbine. Be sure that floor around turbine and switboard is free of movable obstructions. Employee No. 3, station in filter plant. Unlock doors and keep filter plant running. Employee No. 4, station in boiler room and act as messenger between office, shop and boiler room reporting any changes in operating conditions. Operator on Watch, unlock doors in St. light and turbine rooms. Stand by main generating unit. Fireman on Watch, unlock all doors in fireroom, stand by control panel. Fireman off duty, station at water column reporting to fireman on watch. Watchman on Duty, unlock gate, front and office doors, attend telephone until relieved, then take station. Employees No. 5, 6, 8, take stations on roof. Employee No. 9, station in rear yard. Relay any messages from roof watchers to front office or shop. Empoyees No. 7 and 8, stationed at commercial office. Any employee not specifically assigned will report to station in shop and stand by.

Precautions to be Taken. *Don't open main breakers on switchboard.* The only conditions under which the main breakers will be opened are,—a bad break in primaries, a serious fire endangering life or property that may be reported by the *Fire Chief* and/or a direct order by the head of the local War Council. Any request received by telephone *must be verified* by securing the name of party requesting such action.

Breaker controlling street lights should be opened upon receipt of a *blackout order* from the Air Raid headquarters.

The filter plant should be in operation during all air raid periods.

The two-inch fire hose must be laid out, without kinks in the line, with nozzle attached. *Nozzle* to be located in the *shop. Connect all garden hose.*

During blackout periods be sure that the lighting panel in the turbine room is opened last, and service restored first.

Air Raid Alarms.

The public utility workers should be well trained in the current official blackout signals approved by the local Directors of Civilian Protection.

The following signals are transmitted from the District Warning Center through the civilian protection warning systems:

Yellow Signal. This is a confidential preliminary caution signal not to be given by audible public alarm. It indicates the POSSIBILITY of an air raid in the Warning District so warned. This signal is transmitted to key persons, essential industries, railroads, and places within the Warning District where it may be necessary to initiate preparations to insure timely blackout or air raid precautions.

Mobilization and Blackout (BLUE) Signal. This is an audible warning signal indicating the PROBABILITY of an air raid in the Warning District so warned. Upon the sounding of this signal, civilian protection forces assume their duties; pedestrians and traffic may continue or resume movement; during hours of darkness blackouts are initiated.

Air Raid (RED) Signal. This is an audible public warning signal indicating the PROXIMITY of enemy aircraft and the IMMINENCE of an air raid in the Warning District so warned. Upon the sounding of the audible public warning signals, blackout should be completed and pedestrians and vehicles are limited to emergency movement.

All Clear (WHITE) Signal. This signal is a public signal indicating ALL CLEAR in the District so warned. This signal may be transmitted by radio, telephone, police, by turning on street lights which have been extinguished on the BLUE signal, or other available means.

NOTE: Public utility employees should report for duty either on receipt of the confidential YELLOW warning by telephone, or on the sounding of the first audible warning signal (Mobilization and Blackout (BLUE) Signal).

DON'T TELEPHONE.

Questions.

1 When and by whom was first supply built?
2 When did Village purchase property?
3 Give reasons for purchase.
4 Give date of appointment of Board of Water Commissioners.
5 What section of Village Law authorized their appointment?
6 State the authority vested in the Board of Water Commissioners.
7 Who is the administrative body?
8 The executive duties are performed by whom?

9 What are the executives' duties?
10 When was the slow sand filter constructed?
11 What was the source of supply?
12 Describe the character of the supply.
13 Give reasons causing abandonment of slow sand filters.
14 Why are rapid sand filters better adapted to this supply?
15 Describe movement of water from source to user.
16 What type of pumps are used?
17 What motive power is used for pumps?
18 Where is same obtained and what is its cost?
19 What class of utility is operated in conjunction with the water supply?
20 Indicate point of application of chemicals.
21 Where is chlorine applied?
22 Is there an emergency source available?
23 What is called a floating storage reservoir?
24 Describe method used to record location of structures.
25 Sketch a simple graph, showing gallons pumped against hours of pumpage.
26 Why are level measurements more accurate than slope?
27 Describe the characteristics of a centrifugal pump.
28 Describe requirements of 'blackout' operation.

CLASS LESSON NO. I, SECOND HOUR

Water Works Arithmetic

The greater percentage of problems confronting the practical water works operator can be solved by the use of addition, subtraction, multiplication, division and conversion factors. Ratio and proportion may be said to be a combination of multiplication and division. The ratio between two quantities is the quotient (answer) obtained by dividing the first quantity by the second. As an example, the ratio between 5 and 10 is the same as 1 to 2 or ½.

Ratio and Proportion.

Proportion is the equality of ratios, thus, 5 is to 10 as 10 is to 20. The usual sign to denote a ratio is (:) and the equality of ratio as (: :), thus the above should be written 5 : 10 :: 10 : 20. The teacher in the little Red School House used to ask the question, "if 4 apples cost 8 cents, how much will 12 apples cost?" Write this in the modern way, 4 : 8 : : 12 : X, then the factors on both sides $\left(\frac{8 \times 12}{1X \times 4}\right)$ should be equal, solving this to obtain the value of X, $\frac{96}{4} = 24$. The first and last terms are called the "extremes" and the second and third terms called the "means". Therefore, the product of the extremes must equal the product of the means.

Whenever three terms in a proportion are known, the remaining term may be found by the following rules:

> The First Term is equal to the product of the second and third terms divided by the fourth.
>
> The Second Term is equal to the product of the first and fourth, divided by the third.
>
> The Third Term is equal to the product of the first and fourth terms divided by the second.
>
> The Fourth Term is equal to the product of the second and third terms, divided by the first.

When stating a problem in proportion, always use the same class or kinds of terms for the first and third. Likewise, the second and fourth terms should represent the same kinds. That is, amount of work is to days labor as amount of work is to days of labor, or hours worked is to rate of pay as hours worked is to rate of pay. Let "X"

indicate the unknown quantity, whether it be the first, second, third or fourth term of a simple proportion.

Inverse Proportion.

Inverse proportion should be written differently, that is, the first and second terms should be the same kind, the third and fourth terms expressing the other kind. As an example, 10 men will complete a certain project in a month working 48 hours a week. How many men would be required to complete the same project in the same period working 40 hours a week? This inverse proportion should be written:

$$10 : X : : 40 : 48, \text{ thus}$$

$$\frac{10 \times 48}{40} = X \text{ or } \frac{480}{40} = 12 \text{ Men} \quad \text{Answer.}$$

Pipe Sizes, Equivalent Flows and Capacities.

A problem often confronting the practical water works man is to determine pipe sizes, equivalent flows and capacities. The volume of a pipe is calculated by the following formula:

Diameter X Diameter X 0.7854 X Length.

The diameter and length should be expressed in like terms, that is, either in feet or inches.

When the diameter and length are given in inches the result will be in cubic inches. Likewise, with the diameter and length expressed in feet the result will be in cubic feet. Changing these quantities into gallons, use the conversion factors of 231 cubic inches in one gallon and 7½ gallons in one cubic foot. That is, cubic inches of capacity divided by 231 will give gallons, and cubic feet multiplied by 7.5 will result in gallons.

Assume a 6″ inside diameter pipe one foot long, then 6 X 6 X .7854 X 12 = 339.24 cubic inches, $\frac{339.24}{231} =$ 1.46 gallons per foot of pipe. Pipe volumes vary as the square of their diameters. Compare the volume of a 2″ pipe with that of a 6″ from the above formula: Diameter X Diameter X .7854 is to Diameter X Diameter X .7854 as 1 is to "X".

It can be seen that one factor is common to both sides of the formula: 0.7854, that may be left out of all calculations, then we have Diameter X Diameter of smaller pipe times "X" must equal Diameter X Diameter of larger pipe. "X" being the missing factor

of the ratio or: 2 times 2 times "X" equals six times six. The problem then resolves into $\frac{6^2}{2^2} = \frac{36}{4} = 9$. Therefore nine 2" pipes will have the same volume as one 6" pipe.

This formula will apply to comparison of all sizes insofar as volumes are concerned. There is a marked difference between volume and carrying capacity. Volume is the cubical space, while carrying capacity is effected by the condition of the pipe, pressure and number of bends, etc. The calculation of carrying capacity of pipe is beyond the limits of this paper. Handbooks are available giving charts, comparing flows, etc.

Assume an 8" pipe has been bombed and two hydrants with two 2-½" nozzles each are available to by-pass the break. The fire department can furnish sufficient 2½" fire hose to connect the hydrants together. Will the hose maintain full pressure on the 8" line? Neglecting friction and velocity losses then:

$$2\tfrac{1}{2}^2 \text{ times "X"} = 8^2 \text{ or } \frac{64}{6.75} = 9 \text{ plus.}$$

Therefore, it would require approximately ten 2½" hose to maintain full volume in the 8" line.

The above is assuming pressures are equal, in actual practice the ratio will be higher. The flow varies about as the square root of the fifth power of the diameter. The above example should give 18.3—2½ lines to equal one 8" line. This example is cited to illustrate the difference between volume of pipes and carrying capacities or flow.

Pressure Problems.

There is a common misconception that the diameter of a standpipe or tank has a direct relationship to pressure. A column of water 100 ft. high will exert the same pressure at the bottom whether its diameter is one foot or one hundred feet. A column of water one foot high and one square inch in area will supply 0.433 pounds pressure, or 2.31 ft. in height will exert one pound per square inch.

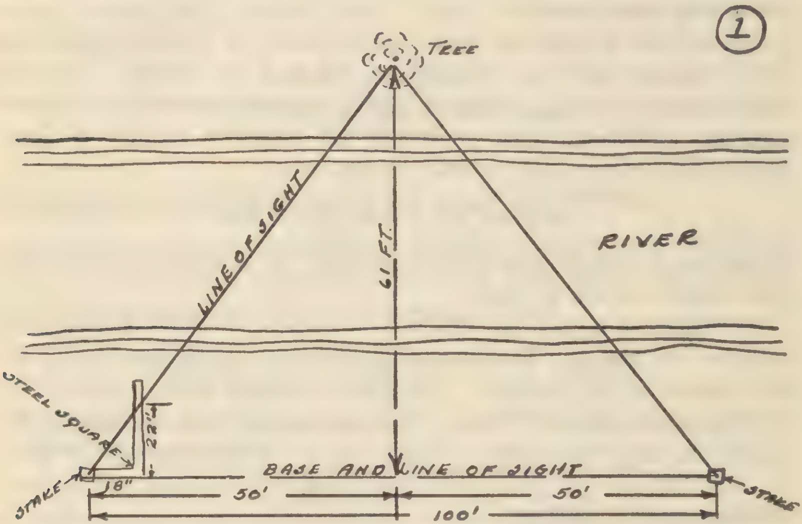
Assume a pump is operating with a suction lift of 12 feet and a discharge head of 200 ft. What is the pressure the pump has to overcome, neglecting friction, etc.? 200 times 0.433 equals 86.6 pounds per square inch. The total hydraulic pressure the pump has to overcome equals (200 plus 12) X 0.433 equals 92 pounds per square inch. The suction lift must always be added to the pressure pumped against to determine the total pressure or work performed by the pump.

Whenever the pump is located below the flow line of the suction,

that is, the water applies pressure to the suction line of the pump, the corresponding pressure should be deducted from the pressure on the discharge side.

Uses of the Steel Square.

The carpenter's steel square is a very versatile tool. A fair sized book could be written describing its uses. The steel square can be used as a substitute for more expensive instruments, such as the



STEEL SQUARE TO ESTIMATE DISTANCE ACROSS A RIVER

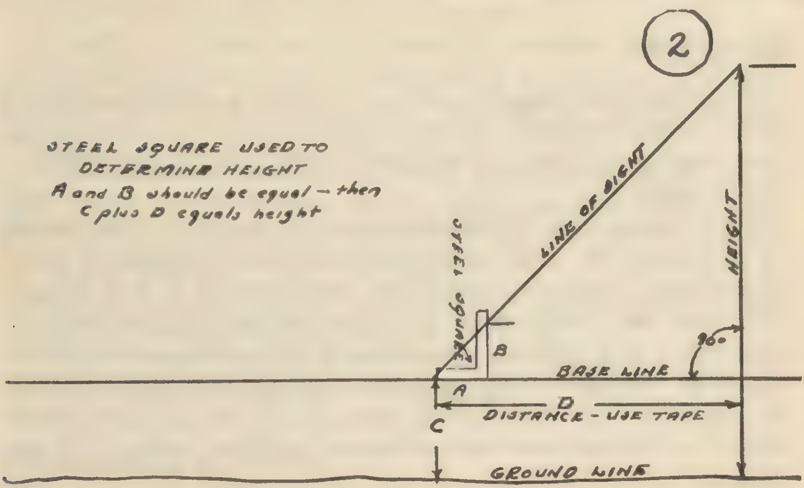
engineer's transit. The steel square is particularly adapted as an aid in solving every day problems for the water works operator.

Suppose you have a water main crossing in the bed of a river that has been washed out during a flood. You must order materials to replace this main, but are unable to cross the river to determine the length of pipe needed to make the repairs. What can you do to ascertain the required length?

The answer is to get a steel square, two stakes and a tape line with which to make an estimate of length without trying to cross the river. The procedure to be followed is something like this: Drive two stakes along one bank of the river. The stakes should be separated at least twice the distance across the river. Drive a small nail in the top of each stake and measure, very carefully, the distance

between the two stakes. Call this distance the BASE. Stretch a string along the base between the two stakes.

Select a tree, stone, fence post or some other object on the opposite side of the river as a marker. This tree or marker should be at right angles from the center point of the base. Lay a steel square with one edge just touching the string. Then sight across the other blade to the marker on the other side of the river, being careful to determine the exact point that the line of sight crosses the blade. To determine the distance across the river from the centerpoint of the BASE, divide the length of the base by two, multiply this by the distance the line of sight crosses the blade pointing across the river and divide the product by the length of the blade touching the string along the base (or in sketch: 18 : 22 : : 50 : X or 18 x = 1100 or X = 61. Make allowances for the distance the base is from the edge of the river and likewise for the distance the marker is from the other side of the river. (This will have to be estimated.)



The same principle applies to the use of a steel square to determine the height of any object—a water tower, pole, building or a hill.

Make a mark on the outside edge of the long blade of the square, equal to the length of the short blade. Hold one end of the tape at the object to be measured. Gradually move backwards from the object, while unreeling the tape, until the line of sight across the bottom corner of the short blade and the mark (with the short blade parallel to

the ground) will just touch the top of the object; then the distance from the object, as indicated by the tape, plus the distance from the ground line to observer's eye, will be approximately the height of the object.

These two examples are used to illustrate the basic principles of proportion and the more intricate trigonometry. When determining the height of the object the ratio is: the length of the blade along the line of the tape is to the length of the tape, as the distance the line of sight crossing the other blade is to the height of the building. That may be called ratio and proportion.

The principle of trigonometry involved is that whenever in a right triangle an angle of 45° is enclosed the opposite side will equal the base. As the line of sight crosses the upright blade at a point equal to the length of the blade touching the tape the enclosed angle will be exactly 45 degrees. Therefore, the length of the Blade "A" is to the distance "D" as the length of blade "B" is to the height. We have "D" divided by "A" multiplied by "B" will equal the height.

Excavation.

Estimating the required time and labor in making repairs to broken mains, hydrants, etc., no general rule can be given. Conditions vary as to ability of workmen, types of soils, accessibility of trench, water, etc.

First compute the estimated amount of material to be handled by calculating the cubic yards to be removed. Assume a trench 10 feet long, 2 feet wide and 5 feet deep: then 10 X 2 X 5 equals 100 cubic feet, which divided by the number of cubic feet in a yard (27) will indicate approximately 3.7 cubic yards. Working under average conditions, a man should excavate and backfill 0.4 cubic yards an hour or 9¼ hours per 10 feet of above trench. Factor to be considered and allowance made for various soil conditions.

Excavate & Backfill dry sand	.5 cu. yd. per hour
Excavate & Backfill dry hardpan	.24 cu. yd. per hour
Excavate & Backfill wet sand	.35 cu. yd. per hour
Excavate & Backfill wet ordinary soil . .	.30 cu. yd. per hour
Excavate & Backfill wet hardpan	.18 cu. yd. per hour
Excavate & Backfill solid rock	.15 cu. yd. per hour

Where work that can be done to an advantage by machine, multiply each quantity by 3 for small jobs.

Trenching over 6 feet deep will require 1½ times as much labor without sheeting.

A factor very useful and easy to remember for estimating small jobs is a trench one foot deep, one foot wide and 10 feet long will require approximately ¼ cubic yard of material to be handled.

Tank Capacity.

Testing of large water meters, especially in smaller plants, sometimes presents a problem that is difficult to solve, due to the lack of capacity of testing equipment. Whenever a large tank or other container is available its volume may be calculated and used to test the meter.

The capacity of any round tank may be determined by the following: Diameter times Diameter times 0.7854 times the height will give the cubic volume. Express the diameter and height in the same terms. That is, feet or inches and the product will be in the respective cubic feet or cubic inches.

Example: A round tank 24 inches in diameter and 6 feet tall is to be used to test a water meter reading in gallons. How many gallons will the tank hold, and how many gallons are in each foot of depth?

First: 24 times 24 times 72 inches times 0.7854 equals 32,572 cubic inches. This divided by 231 shows the tank holds 141.04 gallons; this is 18.849 cubic feet. Each foot in depth in this tank equals 23.50 gallons, or 3.1416 cubic feet.

Example: A square tank 24 inches by 24 inches and 6 ft. deep; find the cubic contents in gallons and cubic feet.

2 times 2 times 6 equals 24 cubic feet or 180 gallons. Each foot in depth will hold 30 gallons or 4 cubic feet.

Mathematics of Power

Horsepower (hp) may be defined as the amount of work required to raise 33,000 pounds one foot in one minute, or one pound 33,000 feet in one minute. The pounds and feet can vary in quantity as long as their product always equals 33,000 for each horsepower. A horsepower hour (Hphr) is this amount of work expended continuously over a period of one hour, or 60 times the amount of the work done in one minute. One horsepower hour represents the energy expended to lift 1,980,000 pounds one foot.

Theoretical horsepower means that the power has been expended without any loss whatsoever, that is 100% efficient. Actual or

brake horsepower takes into consideration such factors as friction, loss in transmission of energy, leakage, slippage and all other factors that tend to lower the efficiency of the unit.

The theoretical horsepower required to raise water can easily be computed by using the following basic figures: 100 gallons per minute elevated 100 feet will require 2.50 horsepower. Both the height and quantity will vary in direct proportion to these factors; that is, 10 gallons per minute, height remaining the same, will require 1/10 as much power or 0.25 hp. Likewise, 100 gallons a minute to a height of 10 feet will require the same amount of power, 0.25 hp. Assume that 575 gallons a minute are to be pumped into a reservoir that has an elevation of 245 feet above the water level of the suction. How much power will be required to pump this water?

The first step is to reduce all terms to common value, that is hundreds, 575/100 will be expressed as 5.75 and the height of 245/100 equals 2.45, then 5.75 times 2.45 times 2.50 will be the power needed. Answer 35.20 horsepower.

The above is assuming that the pumps, etc., are operating at 100 percent efficiency. To determine the required horsepower at any other efficiency, multiply the theoretical horsepower by 100 and divide the result by the percent of known efficiency expressed as a whole number. The answer will give the actual horsepower.

A very useful formula easily retained in one's mind is: Gallons per minute times the head in feet times 0.00025 will equal the theoretical horsepower. Dividing this by the percent efficiency, expressed as a decimal fraction, will give the actual horsepower.

Take the figures given in the above example, 575 gallons per minute to be pumped against a total head of 245 feet, then:

575 times 245 times 0.00025 = 35.218 hp. Assume the over-all efficiency is to be 61%, then $\frac{35.218}{0.61} = 57.7$ actual horsepower required.

Many of the pumping plants are equipped with electrically driven pumps and the energy used is billed in terms of KILOWATT HOURS. Kilowatt hour may be defined as one thousand watts used for one hour. One mechanical horsepower hour is equivalent to 746 watts for one hour. Therefore, the number of kilowatt hours used divided by 746 hours will give the number of horsepower hours. Let's refer to the above example again and express the results in terms of electrical energy, then 57.7 HP times 746 equals 43,044 watts or 43.044 kilowatts and had this amount been used for one hour it can be expressed as 43.044 kilowatt hours.

Another factor to remember is kilowatts or kilowatt hours times 1.34 will equal horsepower or horsepower hours.

Before we conclude our discussion of the subject of horsepower, let us give consideration to the factors that caused the abandonment of the local slow sand filter plant, especially the matter of excessive pumpage due to leakage.

The operating conditions, etc., give us basic figures from which we can calculate the expenditure of power necessary for the excessive pumpage:

Total leakage	125,000,000 gallons
Total height	260 feet
Capacity of pump	1 200 gallons per minute

125 000 000 X 260′ X 0.00025 = 8 124 980 horsepower minutes

$$\frac{8124980}{60} = 135\,416 \text{ horsepower hours.}$$

Converting this into terms of electrical power:

$$\frac{135416 \times 746}{1000} = 101020 \text{ Kilowatt hours.}$$

Cost of each kilowatt hour was placed at 1½¢.

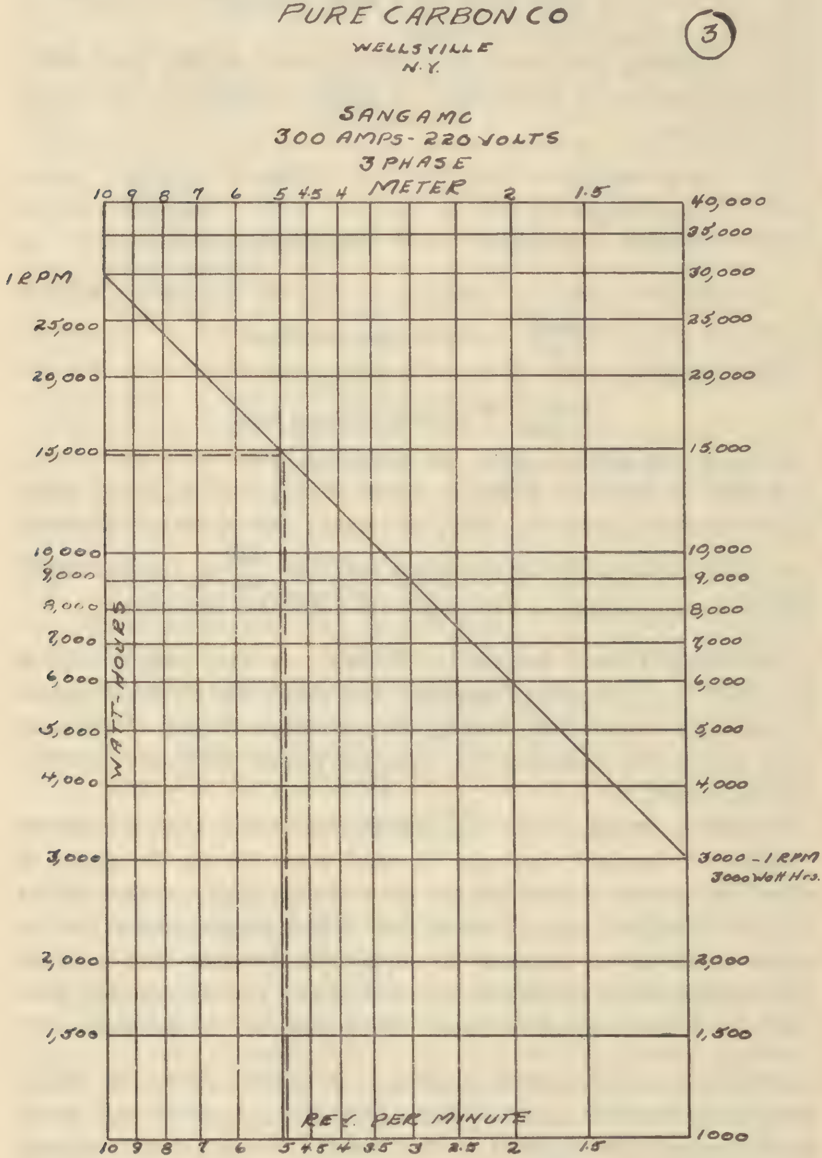
101020 X 0.015 = \$1515.00 Power cost a year to pump water loss by leakage, assuming 100% efficiency. The observed efficiency was 61%. Therefore, the corrected cost was $\frac{1515}{0.61}$ or approximately \$2484.00, representing a 5% return on a \$50,000 investment.

Checking Power Imput to Motors. A very simple method by which the waterworks operator can check the electrical power imput to any motor is by timing the revolutions of disc of the watt hour meter that measures the electrical power purchased to drive the equipment.

It will be necessary for the operator to secure from the power company a constant that can be used when timing the speed at which the meter operates for any given load. This constant differs with the size and type of meter, but it is a simple matter for the agent of the power company to supply the operator with a figure that multiplied by the number of revolutions per minute will indicate the actual amount of power being supplied to the motor.

(NOTE: *Ask the power company to give you a figure that multiplied by the number of revolutions of the disc per minute will result in the horsepower supplied to the motor.* Every power company will have this information in its records.)

A typical example can be cited: Sangamo, Type H, 300 AMP, 220 Volt, 3 Phase, 60 Cycle Meter; One revolution per minute of disc equals 3000 watt hours or 3.0 kwhrs.



Use this figure frequently to determine the operating efficiency of the pump and motor. This simple method of measuring the power imput to a motor-driven pump should be of interest to every operator. Provided the average pressure, and quantity of water pumped are available it becomes a simple calculation to check the efficiency of any unit.

This is called wire to water efficiency and includes the loss in both pump, motor and wiring. The efficiency of the motor can be obtained from the motor manufacturer. The wiring loss should be low, thereby accounting for all losses except that of the pump which can be calculated by the above method after deducting the motor losses.

SKETCH NUMBER THREE will serve a dual purpose, both to illustrate the use of "log" cross section paper and as a slide rule to determine the power imput as indicated by an electric meter.

Enter bottom of the sheet at a point corresponding to the revolutions per minute. Follow this line straight up to the diagonal line, thence across the sheet to the left hand edge marked "Watt hours."

The dotted lines will indicate this procedure assuming that the meter had 4.9 revolutions per minute and 14,700 watt hours imput.

Mathematics of Water, Etc.

The most common terms used in connection with the treatment of water are, grains per gallon (GPG) to express the amounts of chemicals applied; the amount of chlorine applied and the results of chemical analysis are usually expressed as parts per million (PPM).

The number of grains in one pound are 7,000. A gallon of water weighs 8.34 pounds; therefore, one grain per gallon will be at the rate of one to 58,380 parts. A list of commonplace conversion factors are listed at the end of this paper. Examine this list for the factors to reduce GPG to PPM or PPM to GPG.

Assume that you are treating a water supply with chlorine at the rate of 5 pounds per twenty-four hours, that the rate of pumpage is 500 gallons per minute. What is the rate of application expressed in parts per million? 5 pounds per twenty-four hours will be a rate of 0.208 pounds per hour. 500 gallons per minute amounts to 30,000 gallons per hour. Change from gallons to weight of water by multiplying 30,000 by 8.34 or 250,200 pounds. Then $\frac{1,000,000}{250,200}$ times 0.208 equals .823 parts per million.

The cost of treating water is usually based upon the unit of

one million gallons. Therefore, let's change the PPM to pounds per millions.

This rate of treatment, 0.823 PPM, can be changed to pounds per million gallons by using the conversion factor, 8.34, then multiply by 8.34, equals 6.86 pounds per million gallons.

Using the same conditions as in the previous example; how much will it cost to treat 1,000,000 gallons of water with chemicals costing 2¢ per pound when applied at the rate of 0.8 grains per gallon?

The conversion factor given to change grains per gallon into pounds per million gallons is 142.9, therefore 142.9 multiplied by 0.8 equals 114.32 pounds per million gallons at 2¢ per pound costs $2.29.

Assume that the chemical is applied at the rate of ¼ pound per hour while the pumpage rate is 500 gallons per minute. What is the rate expressed in grains per gallon? 500 times 60 equals 30,000 gallons per hour; ¼ pound is equivalent to 1,750 grains; thus 30,000 divided by 1,750 equals 17.1 grains per gallon.

Conversion Factors.

"In connection with the operation of the smaller water works the question of mathematics is sometimes a very serious one, due to the fact that ofttimes the man in charge of the upkeep of the operating records has so many other duties that his time available to devote to the various calculations necessary for the intelligent interpretation of the different phases of operation is limited.

"There are so many time-savers within the reach of everyone that it is possible for every plant operator to have the means of shortening the time necessary to devote to the various mathematical calculations in this field, and keep the percentage of error within permissable range.

"Many different phases of operation of the average plant can be developed graphically on cross section paper in such a manner as to help lighten the task of recording operating results, and at the same time reduce the chances of error in calculations. Many other calculations, such as determining the amount of chlorine applied expressed in parts per million and the grains per gallon of alum (or other chemicals) used, can be made by using 'logarithmic cross section paper.'"

The above is a quotation from an article SIMPLIFIED MATHEMATICS FOR THE PRACTICAL WATER WORKS MAN,

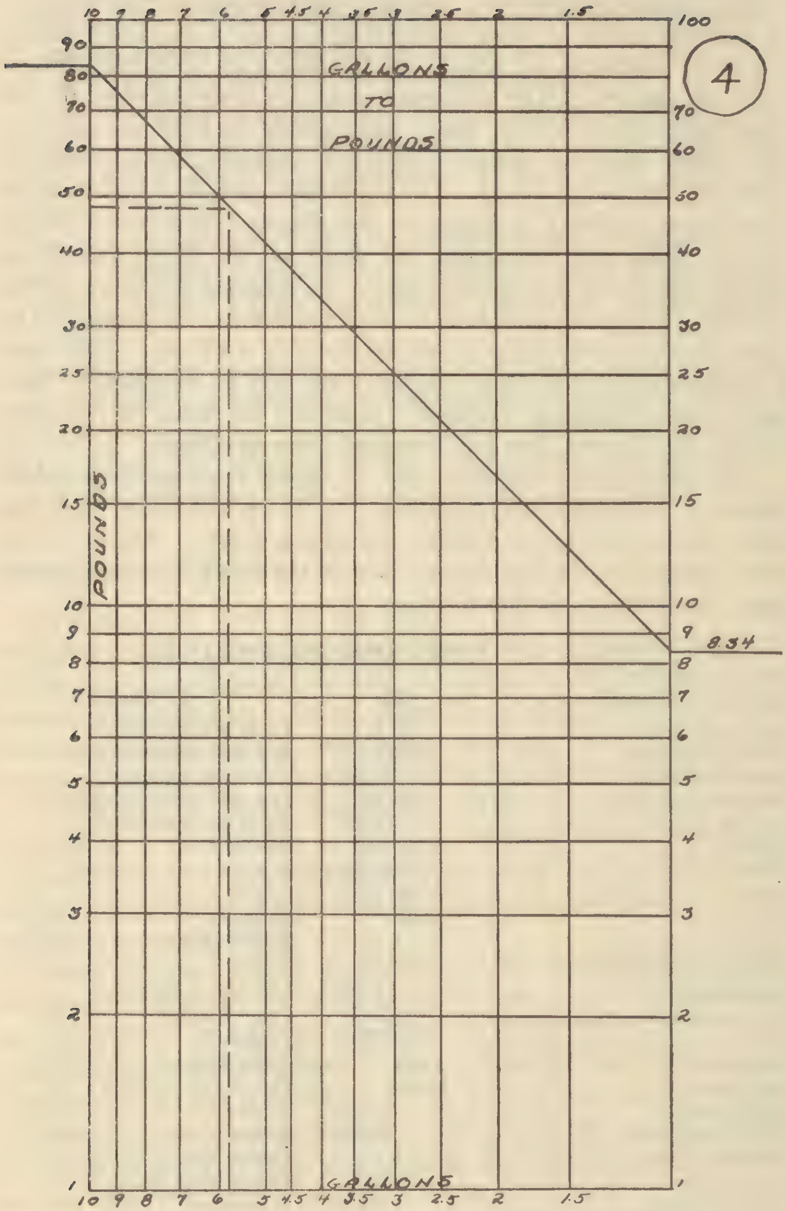
printed in the January 9, 1924 issue of the FIRE AND WATER ENGINEERING, written by the author of this paper.

There is another method, whereby mathematical calculations may be simplified, that of using conversion factors. Conversion factors are simple numbers by which one quantity can be converted into terms of another. The combined use of conversion factors and logarithmic cross section paper will enable anyone to make as many slide rules as desired. Refer to Sketch No. 4. This is illustrated on Sketch No. 4. The conversion factor of 8.34 (weight of water per gallon) is drawn as the diagonal, just as in Sketch No. 3. Enter the bottom of the sheet at the given number of gallons, follow this line straight up to the diagonal line, then across the sheet to the left hand edge to find the number of pounds. The actual result of multiplying 580 by 8.34 is 4,837.20. The value of the numbers in the gallon (bottom) line may be increased by adding as many ciphers as necessary, providing the value of the numbers in the pounds line are increased correspondingly.

Each sheet may represent one or more representative calculations or a combination of several. It is recommended that one sheet be used for the individual conversion factor. A few of the more common conversion factors used in the every day work of the water works man are listed below:

TABLE OF CONVERSION FACTORS

Multiply	*By*	*To Obtain*
Grains per gallon	17.1	Parts per million
Grains per gallon	142.9	Lbs. per million gallons
Parts per million	.0584	Grains per gallon
Parts per million	8.34	Lbs. per million gallons
1 lb. per gallon	.1199	Parts per million
Grams	15.432	Grains
Grams	0.0353	Ounces
Ounce	28.35	Grains
Pound	7000	Grains
Cubic feet (water)	7.481	U. S. gallons
Cubic feet (water)	28.32	Liters
Feet of water	.4335	Lbs. per square inch
Lbs. per square inch	2.307	Feet of water
Gallons	8.345	Pounds
Gallons	231	Cubic inches
Horsepower	33000	Ft.-pounds per min.
Horsepower	.7457	Kilowatts
Horsepowerhour	.7457	Kilowatt-hours
Kilowatt	1.341	Horsepower
Kilowatt-hours	1.341	Horsepower hours
Pounds of water	.1602	Cubic feet
Pounds of water	27.68	Cubic inches
Pounds of water	.1198	Gallons


4
GALLONS
TO
POUNDS
POUNDS
GALLONS
8.34

CLASS LESSON NO. II

Relation of Water to Health

SYLLABUS FOR CLASS TRAINING SESSION NO. 2

2 Hours

Subject. Relation of water to health.

Instructor. Instruction preferably should be given to a combined group of auxiliaries from all towns and villages in the county. An outstanding water works expert, a health officer who has particular knowledge of water matters, or a district engineer of the State Department of Health should serve as instructor.

Scope. *First hour:* Lecture on general aspects of the subjects: waterborne diseases and modes of transmission, germ theory of disease, contamination of water lines through cross-connections, repairs and back siphonage, and related matters. Outline the history of some outstanding waterborne outbreak. For source material, refer to numerous articles in A. W. W. A. Journal, technical magazines, or Rosenau's "Preventive Medicine." Use prepared charts or blackboard sketches to illustrate particular features.

Second hour: Discussion period and oral quiz followed by demonstration of the use of conversion factors and how to calculate dosages to obtain chlorine solutions of various strengths and to solve related problems.

Assign for reading prior to lesson No. 2 some articles appearing in current technical literature relating to bombings or emergency water problems during air raids.

Reference Text for Lesson.

For men who are to serve as foremen of water main repair crews or who are to have any responsibilities whatsoever for restoration of water service following shut-offs or who are to be responsible for the transportation and delivery of water through the use of tank trucks, a full understanding of fundamental relationships between water and health is imperative.

This understanding of these relationships must be so thorough that in any kind of a water emergency situation, the person in charge of a repair job or the organization developed for the door-

to-door delivery of water will more or less automatically apply all of the precautionary measures which will be necessary for protection of health.

The prompt repair of a broken water main is, of course, an urgent necessity under any circumstances. Every minute that the condition exists under which even a limited area of a built up community remains without water, a serious public health hazard as well as a serious fire hazard will prevail. These fire and health hazards will be increased in proportion to the length of time the water main remains out of service, in proportion to the area of the community which is affected, and in proportion to the degree of the catastrophe which has occurred.

You can see, therefore, that speed in effecting the repair of a broken water main or in solving any other kind of an emergency water problem is a matter of vital importance.

Emergency Repairs and Health Protection.

But speed alone may invite disaster. The restoration of water in the main to the original pressure conditions which existed prior to the time the break occurred will by the same token so far as water supply is concerned, restore fire protection to the status which existed before the break occurred. But unfortunately the public health hazards which were created when the break occurred will not be eliminated, but may actually be greatly increased unless many special precautions to overcome these hazards are applied at the time and subsequent to the making of the repairs.

While speed in effecting repairs is a condition much to be sought, it involves all of the dangers which are implied in the old adage of "Haste Makes Waste."

As related to repair of broken water mains or solution of other emergency water problems we are shooting not for speed alone, but a proper coordination between speed and the precautions which must be taken to counteract or neutralize the effects of the serious contamination of the water in the mains which took place when the break occurred, and the equally serious contamination which may be introduced at the time the repair work is undertaken.

In all of our thinking through the progress of this course of instruction, we shall need to keep in mind at all times that in any situation involving the disruption of water service or the handling of drinking water we are dealing with situations where in all probability the excreta and urine or sewage from human beings has already entered the water lines, or when most certainly such

contamination will be introduced into our drinking water unless certain rather simple but specific precautions are taken.

Before we get into a discussion as to how and under what circumstances human sewage may get into water piping systems, let us examine into the constituents of sewage which may have such an adverse effect upon our health.

The Common Water-Borne Diseases.

(Use blackboard) Let us chalk down the names of some of the more common diseases to which human flesh is heir, and which are easily transmissible through the medium of drinking water which has become contaminated by human sewage. (Call on students to name various diseases which are water borne.)

Typhoid Fever	Cholera
Para-typhoid Fever	Bacillary Dysentery

Amoebic Dysentery

Gastro-enteritis (Diarrhea)

Others

Typhoid and Para-Typhoid Fevers.

Let us consider Typhoid and Para-typhoid Fever for a moment. All of you know that these diseases have a severe and prolonged prostrating effect if they do not result in death. In typhoid epidemics the death rate among those who have contracted the disease may run about 10 per cent. Para-typhoid which is a sort of first cousin to Typhoid is not usually quite so severe. Both of these diseases are caused by minute living organisms of certain definite strains, called bacteria.

Just as all mankind is divided into various races, white, black, yellow, etc., so are bacteria divided into groups of various kinds. And each group is divided into species and families and so on. Finally we get down to a particular organism called Bacillus Typhosus, which is the particular organism that when taken in through the mouth of any susceptible person in sufficient numbers will produce a case of Typhoid Fever.

All of these so-called water borne diseases are caused by specific organisms of one kind or another which have definite identifying characteristics. Starting with some feces from a human being suf-

fering with Typhoid for example, each typhoid organism is milling around in the company of millions of others of its kind and in the company of millions of other bacteria and living organisms of different kinds. Hundreds of kinds of bacteria will be found in any small specimen of human excreta. Many of them are not dangerous in the sense that they will produce disease, but many of them may be the seeds for disease. There are both good and bad bacteria; and B. Typhosus is a bad one.

Now to get back to this picture of millions of typhoid bacteria milling around in the company of millions of other bacteria in a stool specimen from a typhoid patient, each little typhoid organism, so to speak, carries the same identification tag around its neck. It takes an expert bacteriologist to find these tags and read them. It can be done through a series of tests, under which a minute amount of the stool specimen is placed in a test tube containing a particular kind of food which will be conducive to the growth of certain kinds of organisms, including B. Typhosus. Through a succession of similar tests, using different kinds of foods under different conditions of control in each stage of the series of tests, a sufficiently pure culture of typhoid organisms is finally separated, so that after various staining processes, the particular organisms may be readily identified under a high powered microscope.

Typhoid Carriers.

Now a good question for someone to ask is why typhoid organisms may be expected to be present in the sewage of a community, particularly when there are no cases of the disease in the community.

It so happens that roughly about 4 per cent of all people who contract Typhoid Fever develop into so-called "carriers" of the disease for substantial periods of time following their apparently complete recovery from the disease. That is, after they become well they continue to remain infected for various periods of time and will discharge these organisms in the excreta or urine eliminated from their bodies. Some of these persons remain carriers for life and are a constant threat to the community, particularly if their occupations are such that they are involved in any way in the handling or preparation of foods.

These typhoid organisms are so potent that when a so-called "carrier" who may be a waitress in a restaurant, for example, returns from a toilet without having practically sterilized her hands, and pushes a plate of food over the counter to you, you stand in great danger of contracting Typhoid Fever from two to three weeks later.

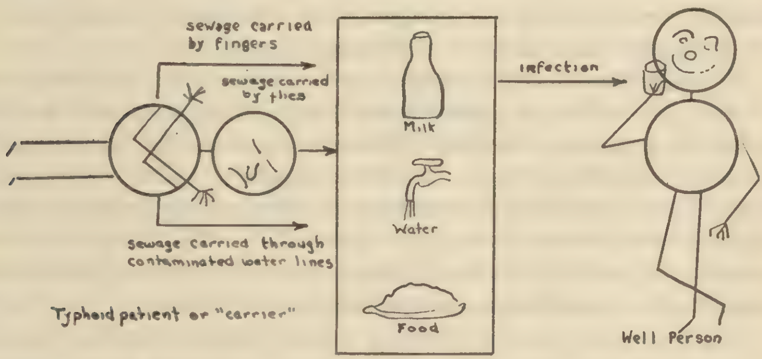
which is about the normal incubation period for the disease. Or if this same waitress passes you a glass of water inside of which her fingers were inserted (demonstrate with use of an empty glass to show how contamination is introduced) before the glass was filled with pure and sparkling water, you stand in equal jeopardy of contracting the disease.

In New York State, of course, so-called typhoid "carriers" are placed under regulation and control by the State Health authorities. Once the identity of a carrier becomes known, the carrier is prohibited from engaging in any food handling occupations and frequent checks are made to see that the carrier observes and follows the regulations. But there are many typhoid carriers who are not yet known, who may not know that they are carriers, and who will not be discovered until after an outbreak occurs and a detailed epidemiological investigation of the cases finally results in the discovery of the carrier.

In any community it can be taken for granted that there are either known or unknown typhoid carriers who daily discharge typhoid organisms into the house plumbing system and thence to the sewers. Therefore, the presence of such organisms in sewage must always be regarded as certain.

Chain of Typhoid Transmission.

In the cycle of transmission of typhoid or for that matter any of the water borne diseases a certain chain is always established. (Use blackboard and draw following sketch)



Starting with a case of Typhoid or a typhoid carrier, transmission of disease to a well person always will involve the transportation somehow of a very minute quantity of the urine or feces of the sick

person to the mouth of the well person. This could be direct through contact such as a "carrier" mother inserting her fingers into her child's mouth to remove a marble.

Generally, however, the chain of transmission will pass through milk, water or food. All of these are taken in through the mouth. All that is needed to produce a case of typhoid in the well person is to get the milk, water or food contaminated with a few typhoid organisms.

This can take place in a number of ways, as I have indicated in the sketch. Sewage left under the finger nails after a carrier or a case has used the toilet may easily find its way into a glass of milk or water or in the chicken salad served to the well person.

Or a fly which feeds on excreta deposited by the typhoid patient in a privy may easily carry the organisms to the milk, water glass or food on the dining room table.

Or sewage from the patient or carrier discharged into the house plumbing system and thence to street sewers may get into water lines under certain peculiar abnormal conditions which we shall presently consider and thus become a cause for the mass infection of the community through the medium of drinking water or the infection of milk or other foods by the contaminated water.

Cholera, Dysentery, Gastro-Enteritis, Etc.

Cholera was once present to some extent in the United States. It is spread in the same general way as typhoid. It is no longer a problem in this country, but what with American soldiers dispatched all over the world throughout countries where Cholera may be prevalent, the disease has some chance of becoming reestablished.

The Dysenteries, both Bacillary and Amoebic, are transmissable through the medium of contaminated water. Each disease is due to a specific organism, Bacillary Dysentery to a specific bacillus and Amoebic Dysentery to a one-celled organism called Entamoeba Histolytica. The bloody dysenteries are usually of the bacillary type. Both of these diseases have severe prostrating effects and very frequently will result in death. In former years high infant death rates were due to a considerable extent to Bacillary Dysentery.

Gastro-enteritis usually involving a large number of cases will as a rule follow any serious contamination of a municipal water supply with sewage. There are numerous outbreaks of Gastro-enteritis of limited extent. Fortunately the illness is not severe, produces diarrheal effects only for a day or two, but is extremely discomforting. And

the appearance of a Gastro-enteritis outbreak may be the forerunner of an outbreak of Typhoid or Dysentery. In large cities it is not uncommon for thousands of cases to develop following slight contamination of the water supply and these may or may not be followed by Typhoid or Dysentery.

There are, of course, other diseases which may be water borne, although we are not certain in some cases as to the exact mode of transmission. It is possible to transmit Hook Worm or Tape Worm through grossly polluted water, although these are not the usual methods of transmission. The virus of Infantile Paralysis has been recovered from sewage and it is possible that this disease could be transmitted through polluted water, although this is not definitely known to be true.

Some Features of Disease Epidemics.

Throughout the past 40 years there have been over the country at large a great many outbreaks of Typhoid and Dysentery which have been carefully studied and have contributed a great deal of knowledge to the ways in which these diseases are spread. There is nothing like a few examples to help us understand these routes of infection. There are innumerable examples recorded in medical literature which might be selected for purposes of illustration. Each one is different and has occurred under different circumstances, but always they have had some characteristics in common. The chain of transmission from carrier or patient to the well person either through milk, water, or foods is always present and frequently is retraceable in detail.

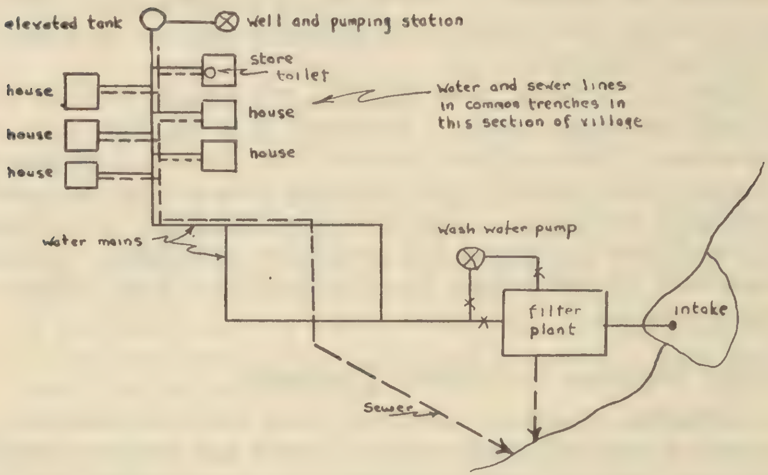
As regards water-borne outbreaks, they are invariably due to causes which usually are recognized as potentially dangerous in advance, but which due to human carelessness or complacency are forgotten or disregarded until the outbreak occurs.

Let us consider a few of the salient features associated with one or two water-borne outbreaks which will bring out more clearly the relationships between water and health. I shall discuss one where contamination of the public water occurred to about the extent that one might expect in the event a water main was broken by a demolition bomb, or water from a polluted stream was pumped into a water system without treatment.

A Typhoid Outbreak.

The locale for the epidemic of Typhoid Fever in a small village which occurred several years ago is illustrated generally by this

sketch. It is not accurate, but will illustrate the principal features involved.



In this village surface water after treatment in the filter plant was pumped to consumers. At the filter plant whenever it became necessary to wash the filters, because there was no wash water tank, the wash water was pumped directly from the main. This produced a suction or negative head in the system which was noticeable particularly in the high section of the village where I have shown some houses.

To counteract this condition the village installed a well and pumped water from this well into an elevated tank. The idea was that as long as the elevated tank was kept full, the system would be under pressure and negative heads in this high portion of the village would not be produced. But because of freezing weather this tank was thrown out of service during the winter months. In this particular village the water lines and sewer lines, at least in the upper portion of the village, were laid in the same trenches many years ago due to rock formations. In some cases sewers may be on the same plane or perhaps above the water main. Naturally sewers leak some and water mains may spring a leak now and then. But even so there would be no particular danger as long as the water system is kept under positive pressure at all times. But that was the rub. With the elevated tank out of operation during the winter time, whenever filter washing operations were begun there would be sufficient negative heads produced in the high section of the village to suck in air at the hydrants of some of these houses.

Obviously under such conditions, with leaky water and sewer lines laid in the same trenches, some sewage would be pulled into the waterlines of this section whenever the filters were washed. This was exactly the condition which produced 8 or 9 typhoid cases along one street in this section of the village.

A typhoid carrier got a job in a grocery store located in this section. Quite obviously he used the toilet at a time when negative heads existed in the water lines. When the toilet was flushed some of the dangerous typhoid organisms were sucked into the water main with the result that the main throughout the length of the street became polluted. Once such contamination entered the main, most of it remained in there when the pressures were restored except for the slight leakage which also would take place from the water main to the sewers. Water drawn from house taps after the outbreak occurred still showed gross pollution. The single typhoid carrier thus produced an outbreak of 8 or 9 cases along this street.

Subsequently, of course, the riser pipe on the elevated tank was insulated, and the tank thereafter was kept in operation during the winter months. Also the village made a separation of its water and sewer lines along this particular street where trouble would be most likely to develop. As long as the system is kept under positive pressure there is no particular danger but there is always the danger that some condition may arise, through a broken water main or otherwise or perhaps in some other section of the village where there are still water and sewer lines in the same trenches, when negative heads may suddenly be created in a limited section of the water system and thus cause trouble. The dangers in the village of course are not imminent at all under normal conditions but it might be a different story if the village were bombed or sabotaged.

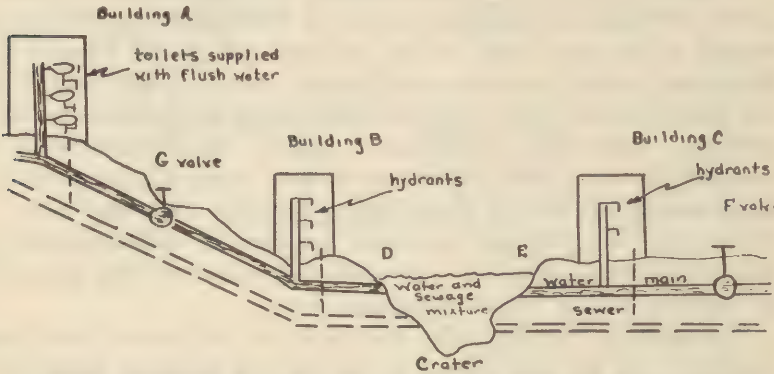
I have described this outbreak because it has a particular relationship to the general situation which will always exist when there is a break in a water main and a draining of the water system. This is exactly the situation which could easily arise in the event of a bombing attack, or sabotage of a water main, or during a large fire through excessive pumping on the system.

How a Broken Main Endangers Health.

Let us consider the conditions which are set up favorable for the gross pollution of the water in a distribution system when a break in a water main occurs. We will assume that the break has been due to bombing or sabotage and has been of sufficient magnitude to cause

a total water failure in the area served by the particular water main. We will assume further that the explosion has resulted in the simultaneous breakage of a nearby sewer and in the formation of a crater.

(Use black board) Diagramatically we can illustrate the situation as follows:



SKETCH ILLUSTRATING HOW WATER LINES WILL BECOME CONTAMINATED FOLLOWING BREAK IN A WATER MAIN

The crater formed by bomb explosion which wrecks the water main and sewer line fills with a mixture of water and sewage. If the flow of water in the main is normally toward Building A, when the break occurs until valves F and G are closed, water will continue to flow under pressure into the crater at E. The hydrants in Building C may still supply some water, but pressures will be greatly reduced because most of the water supply is being wasted into the crater at E. The section of the main and all connected laterals above D will no longer be supplied with water and this section of the water system will drain into the crater at D.

The draining of the system above D will create back siphonage conditions as a result of which the sewage from toilet bowls or waste lines in Building A may be sucked into the water line through defective plumbing fixtures and be delivered at water hydrants in Building B as long as the water level in the main above Building B is higher than the level of the faucets in Building B. In the same way due to great pressure reductions in the house below E back siphonage conditions may be created resulting in the suction of sewage into water lines through defective plumbing fixtures in Building C and be delivered later to hydrants in Building C or other houses in the neighborhood.

Sometime later and after back siphonage action has been in operation sufficiently long to result in general contamination of the water lines, the break would be valved off by closing valves F and G. In all probability when the explosion occurred, dirt, debris and sewage pollution was driven in both directions and for several feet into both ends of the broken water main resulting in the introduction of serious contamination of the water lines for several hundred feet perhaps on either side of the break. Also in all probability the explosion resulted in only partial stoppages in the water and sewer pipes, sufficient in the sewer to prevent the effective draining of the crater as long as water continues to flow at E and insufficient in the water pipe to prevent the flow or seepage of polluted water into the broken water pipe at E after valve F is closed.

Causes of Water Pollution.

When a break of the kind illustrated occurs general contamination of the water line above and below the break will result from any one or all of the following causes:

(a) Back siphonage of pollution into water lines through defective plumbing fixtures caused either by the greatly increased velocity of flow in the main due to free flow of water into the crater at the break or drainage of the water system into the crater above the break.

(b) Flow or seepage of polluted water from the crater into the water line below the break after the break has been valved off.

(c) Dirt, debris and sewage blown into the main in both directions at the time the explosion occurred.

Back siphonage conditions can be created in an infinite variety of ways. Back siphonage caused by drainage of a water system is a simple proposition.

The effect is the same as when you fill a garden hose with water, put a kink in the hose to prevent the loss of water, immerse one end in the goldfish pool in the backyard, carry the other end to some point which is lower than the bottom of the pool, and then straighten out the hose. Siphonic action is started and will continue until the goldfish pool is completely drained. (This should be demonstrated through the use of a small piece of rubber tubing and two buckets).

In the example on the blackboard, this is exactly what happens. Siphonic action is set up in the main and house piping systems. The house piping system is connected to some defective plumbing fixtures in Building A. In some cases the polluted water in the toilet bowls of Building A will be sucked into the house piping

system and thence into the water main. On down the street is Building B. As long as the water level in the water main above B is higher than the level of faucets in Building B, with some allowance for friction losses and the aspirational effects produced by the free drainage of water at D it will be possible to draw water from hydrants in Building B and some of this water quite readily may be the sewage from toilet bowls in Building A.

Emergency Precautions to Guard Health.

This is a rather simple illustration of the principles of back flow or siphonage of sewage into water lines and illustrates several precautions which need to be taken to protect the public health from the instant a break occurs until it is repaired and water service, both in quantity and quality, is restored to a normal condition.

First, from the time a break occurs it must be assumed that the water supply below and extending for some distance above the break is dangerously polluted. Sudden reduction of pressures to the point that water barely trickles out of taps will be the first warning that back siphonage conditions are being established. Aspiration of air at faucets will be convincing evidence that back siphonage is established. Residents of a community should be taught: whenever these symptoms are noticed they should boil all drinking water until pressures are restored to normal, the system has been thoroughly flushed, and local water and health officials pronounce the water to be safe again for drinking. Because these conditions are likely to happen under the conditions of an emergency, the warnings distributed to householders should carry instructions to the effect that when bombs begin to fall in the community or sabotage of water mains or the water supply is either accomplished or attempted, all water from that time on which is used for drinking purposes should be boiled or disinfected until such time as it is pronounced safe again by the local water and health authorities.

Second, at the time the broken main is repaired the pipes on both sides of the break and including house services and the new section of pipe inserted at the break should be thoroughly cleaned, disinfected and flushed. This disinfecting and flushing process should be extended throughout the entire area affected by the break. In subsequent lessons in this course the procedures for accomplishing this disinfection will be covered.

Third, after cleansing, disinfection and flushing of mains and house service in the affected section all water used for drinking

purposes should continue to be boiled until after bacteriological examination of samples collected from representative points on the system throughout the affected area furnish positive proofs that the water is again safe. This is extremely important, for irrespective of the thoroughness with which we try to do a job of disinfecting water mains and house services, the probabilities are that we shall not do a 100 per cent job and we should always play on the side of safety.

Following any general contamination of a water system of a community, even though the most painstaking care has been exercised in the disinfection and flushing of the system, the chances are that from two to three weeks will be required before the last trace of pollution in the system has been removed. It is quite easy for a water system to become grossly polluted. To get this pollution completely removed is a horse of another color.

Two Outbreaks of Amoebic Dysentery.

Let us consider the principal aspects of two other outbreaks which occurred in Chicago a few years ago which involved the spread of Amoebic Dysentery through the medium of drinking water, contaminated to about the extent that one might expect would occur if untreated water from a moderately sewage-polluted source were to be pumped without adequate treatment into a distribution system. They will illustrate several important points that need to be constantly borne in mind. Again I shall try not to be too accurate in outlining just what happened, but will give you my impressions of what probably happened based upon written accounts of the outbreaks which appeared in the literature of the times.

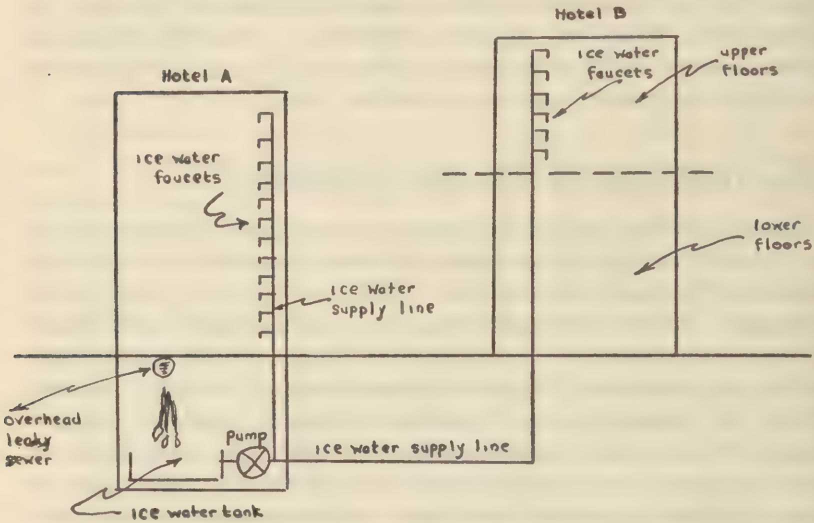
The first outbreak occurred during the Chicago World's Fair. All over the country cases of Amoebic Dysentery began to appear and epidemiological studies of these cases developed the general picture that something must have been wrong in two Chicago hotels. These hotels were across the street from each other. Most of the cases reported that several weeks earlier while visiting the fair they had been registered at one or the other of these two hotels. The peculiar thing about these stories was that in one hotel cases had occurred apparently among guests quartered on all floors, while in the other the cases pretty largely were confined to persons who had been quartered only on the top eight or ten floors.

Thorough investigations revealed that a good many things could have happened.

The picture was complicated to a considerable extent by the possibilities which existed for contamination of water lines through back-siphonage, the transmission of cases through food handlers, and the contamination of food in the basement of one of the hotels caused by the surcharge of sewers during heavy rains and flooding of the basement.

But what most probably occurred, based upon what I have read concerning this outbreak, was this:

(Use blackboard)



Sketch Illustrating Outbreak of Amoebic Dysentery

The top floors of Hotel B to which cases of Dysentery were related was supplied with ice water pumped from a tank in the basement of Hotel A, while all floors in Hotel A were supplied with ice water from the same source. A leaky overhead sewer was found directly above the ice water tank so that pollution of the ice water was readily possible. The fact that the cases were distributed rather generally according to the arrangement for the supply of ice water to both hotels seems pretty good evidence that the outbreak was primarily due to contamination of the ice water supply.

Since then, of course, the conditions have been corrected and the city has carried on a very comprehensive program to eliminate the possibility of back siphonage and similar conditions in hotels and

other buildings so that now Chicago is probably better protected against a repetition of such an outbreak than most other large cities.

The second outbreak occurred following the disastrous Chicago Stock Yard Fire a year or so later. The cases were traced largely to firemen and persons who had visited the fire and who during the time they were on the scene, drank water from faucets supplying watering troughs.

As I recall, the water supply for the stock yards was filtered and chlorinated water from a moderately polluted creek, but under normal conditions of safe quality. When the fire occurred, in order to get sufficient water for fire fighting it was necessary to throw the filters out of service, but precautions were taken to increase the chlorine dosage so that all water pumped was rather heavily chlorinated. The rub was, however, that even moderately heavy chlorination is ineffective on the organisms which produce Amoebic Dysentery. Filtration is effective in removing these organisms, but chlorine alone unless in very high doses will not kill them. Hence the cases occurred among the firemen and visitors who attended this fire.

Now perhaps from what I have said and the few examples which I have given, you will appreciate the reasons for the precautions which must be taken to disinfect water lines during and following repairs and to provide adequate treatment for any water which is exposed or may be subject to human sewage pollution and which is pumped into a water system to meet the flow requirements of an emergency or which may be distributed to residents through the use of milk cans or tank trucks.

After all, there are only a few fundamental principles which must be understood; but a thorough understanding of these is absolutely essential, if in connection with the emergency water service duties which we may be called upon to perform, we are to apply effectively those measures which are necessary to guard against a possible water borne outbreak that may result in a catastrophe more serious than the one we are trying to prevent or reduce.

On the lesson sheet are summarized the essential points which I feel that you as water works auxiliaries should come to thoroughly understand and keep constantly in mind as you progress through this course of instruction and graduate finally into what I hope will never be the field of practical application.

It is well, however, to get as fully prepared as possible to handle water emergencies, the exact nature of which we can never know in advance of their actual occurrence.

Sample questions for oral quiz for Lesson II

Name two water borne diseases the causative organisms of which should always be assumed as present in sewage? *A.* Typhoid and Dysentery.

What is a typhoid or dysentery "Carrier"? *A.* Any person who, apparently well, continues to discharge the causative organisms of either of these diseases in the body wastes.

About what proportion of persons who contract typhoid fever develop into carriers? *A.* Four per cent.

To produce a case of typhoid, what simple chain of transmission must be established? *A.* Typhoid organisms contained in the feces or urine of a sick person or carrier must pass to the mouth of the well person.

What are some of the vehicles through which typhoid or dysentery may be spread? *A.* Infected water, milk or foods.

Name several ways in which water may be contaminated? *A.* Fingers or flies may contaminate drinking water glass. Public water supplies may be contaminated through cross connections, back siphonage, repairs, lapses in treatment, etc.

What may happen when pressure in a water main is greatly reduced or falls to zero either as a result of excessive draft or a broken main? *A.* Sewage in buildings along the street may be siphoned into the water line through defective fixtures.

When is there a particular danger from having a blow-off connection from a water main connected to a sewer? *A.* Whenever the pressure in the water main is reduced sufficiently to set up back-siphonage action.

When a water main is bombed, in what ways is sewage likely to enter the water system? *A.* Blown into the main on both sides of the break. Back-siphonage pulls in sewage from houses along street. Polluted water in crater drains into pipe. Pollution introduced when repairs are made.

For how long a period should people continue to boil drinking water when this precaution is practiced after an actual bombing attack? *A.* Until pronounced safe by the local health and water officials.

Will boiling of water kill waterborne disease organisms? *A.* Yes.

Will chlorination kill waterborne disease organisms? *A.* Yes, in small doses except for Amoebic Dysentery organisms. Causative

organisms of Amoebic Dysentery require fairly heavy chlorine doses.

Why must heavy doses of chlorine be used to disinfect water lines? *A.* Because, in cases of gross pollution, there must be sufficient chlorine present to penetrate small solids and to kill amoebic dysentery organisms which may be present in the sewage.

Why are not heavy doses of chlorine required in the ordinary treatment of water supplies when heavy doses are required for disinfection of water lines? *A.* Public water supplies generally are taken from sources which are not subject to gross pollution and therefore the water to begin with is of sufficient clarity so that small doses of chlorine are effective in killing dangerous bacteria. But if the supply is derived from moderately polluted sources where pollution by amoebic dysentery organisms may be possible, then such supplies are filtered; and filtration is effective in removing these as well as other organisms. After careful filtration only small chlorine doses are needed as a matter of precaution.

What danger is there in drinking water from a mountain stream in a fairly well isolated region? *A.* Some hunter who happens to be a "carrier" may have polluted the water which reaches you at the particular time you take a drink.

Solution of Typical Problems.

Example 1. A water plant operator has practically nothing in the way of laboratory equipment except a pipette, a can of H.T.H., an orthotolidine test outfit, and eleven clean quart milk bottles. He wants to make an approximate chlorine demand test of the water before it is chlorinated. How should he proceed?

Solution. He must first prepare a chlorine solution of known strength using distilled water purchased from a drug store. The can of H.T.H. according to the label contains stable calcium hypochlorite having 65 per cent available chlorine by weight. On page 87 of NYS Dept. of Health Bulletin No. 22 "Water Supply Control" it says that "*61.535 ounces* (usually taken as 3¾ pounds) of 65 per cent H.T.H. would be required to prepare 30 gallons of solution containing exactly 1.0 per cent available chlorine." He therefore decides that with the help of the local druggist in weighing the chemical he will prepare one quart of 1.0 per cent chlorine solution. To determine the amount of H.T.H. which he should add to one quart of water to get a 1.0 per cent solution he sets up the ratio

and proportion that 61.535 ounces : 30 gallons : : x ounces : 0.25 gallons and then he solves for X.

$$\frac{(61.535)\ (0.25)}{30} = 0.513 \text{ ounces}$$

He therefore adds 0.51 ounces to the quart of distilled water.

In case he does not have any reference books which would help him solve the problem on a ratio and proportion basis he could proceed with the calculation as follows:

One gallon of water weighs 8.3 pounds. Therefore a quart of water weighs $\frac{8.3}{4}$ = 2.075 pounds. To get a 1 per cent solution he must have .01 x 2.075 or 0.02075 pounds of chlorine or 0.02075 x 16 = 0.33 ounces of chlorine dissolved in one quart of water. This is not absolutely accurate but is close enough for the purpose. But because the H.T.H. contains only 65 percent available chlorine he must dissolve $\frac{0.332}{0.65}$ = 0.51 ounces of the H.T.H. in one quart of distilled water.

Now this one percent solution will be too strong for his work. A 1% solution is the same as $\frac{1}{100}$ or $\frac{10}{1000}$ or $\frac{10{,}000}{1{,}000{,}000}$ or 10,000 parts per million chlorine solution. He needs actually a solution containing about 1,000 parts per million, so he measures out 10 cc of the 10,000 parts per million solution and adds to it 90 cc of distilled water and he gets 100 cc of 1000 parts per million chlorine solution.

He now sets up a series of ten quart bottles of the water to be tested. Each quart contains approximately 956 cubic centimeters when filled to the base of the rim which supports the bottle cap. To make a little room for the addition of the chlorine solution let us say that he removes 56 cubic centimeters of water from each bottle. Each bottle now contains as near as he can measure it, 900 cubic centimeters of water.

To the first bottle he adds 1 cc of the 1000 parts per million solution, 2 cc of the solution to the second bottle and so on until he puts 10 cc of the solution in the tenth bottle. After mixing he allows the mixtures in the bottles to stand for ten minutes and then takes a sample from each and makes a residual chlorine test.

He finds that he gets no residual in the first and second bottle but he gets 0.1 in the sample from the third bottle. The question is: what is the approximate ten minute chlorine demand of the water?

He added 3 cc of the 1000 parts per million solution to 900 cc of water in the third bottle, thus creating a solution which if no organic matter were present in the raw water would have contained $\frac{3}{903}$ x

1000 or 3.3 parts per million of chlorine. But he wound up with a residual of 0.1 part per million so the organic matter in the water must have consumed 3.2 parts per million. Therefore the 10 minute chlorine demand of the water is approximately 3.2 parts per million.

Example 2. In example 1, the chlorine demand of the raw water normally is about 0.5 parts per million. Upon finding a sudden chlorine demand of 3.2 parts per million the operator knows immediately that his normal chlorine treatment of the water will be grossly insufficient. He wants immediately to adjust the dosage so that he will get a residual in the treated water of 0.5 parts per million after a 10 minute contact period.

Solution. He can do this by trial and error, adding increasing quantities of chlorine to the flow of water until he gets the desired residual but this may result in letting untreated water go to the system. The instant he suspects or finds out that treatment is inadequate he should stop pumping water and not resume pumping until he is sure that the dose he adds is going to be sufficient. By making chlorine residual tests at, say, hourly intervals he should be able to catch any serious fluctuations in chlorine demand by noting the drop or increase in the residuals. If he gets a significant decrease in the residual he should make residual tests at 5 or 10 minute intervals and of course keep the chlorine dosage stepped up with the requirements so as to maintain the desired residual of 0.5 p.p.m. But we shall suppose that he soon comes to realize that the machine he has connected is not going to have sufficient capacity to meet the chlorine demand of the water if it keeps on increasing at about the rate he has been able to observe it. To play safe he shuts off the supply to the system and we will assume that he made a chlorine demand test and found it to be 3.2 parts per million as in Example 1. He thinks the chlorine demand may still be increasing, so to play safe he takes into account the observed rate of increase and decides that he will add 5 parts per million to the flow of water when he resumes pumping and then cut the dosage down as required.

His pump pumps at the rate of 100 gallons per minute. The question is how much chlorine should he feed to the flow of water when he resumes pumping to get a dose of 5 parts per million?

8.3 lbs. of chlorine fed to 1,000,000 gallons of water = a dose of 1 part per million. 100 gallons per minute equals 100 x 60 = 6,000 gallons per hour. Therefore to calculate the dose required to give

one part per million in 6,000 gallons of water per hour we can set up the proportion,

$$\frac{8.3 \text{ lbs.}}{1{,}000{,}000 \text{ gallons}} = \frac{x \text{ pounds}}{6{,}000 \text{ gallons}}$$

or

$$x = \frac{(6000)\ (8.3)}{1{,}000{,}000} = 0.049 \text{ pounds per hour}$$

or 1.18 pounds per day.

Therefore to get a dose of 5 parts per million he would adjust his chlorinator to feed at the rate of 5 x 1.18 or 5.9 pounds per day.

Suppose at this rate he finds that he gets a residual of 1.8 parts per million. This checks his chlorine demand obtained perhaps 15 minutes earlier and thus indicates that probably the peak chlorine demand has been reached. Therefore he could cut down on his chlorine dosage somewhat by trial and error until he gets the desired residual of 0.5 p.p.m.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 2

To be reproduced locally for distribution to all Class Members

Relation of Water to Health

A thorough understanding of the fundamental relationships between water and health is imperative if proper precautionary and protective measures are to be applied effectively in an emergency.

Where there is a water main break, certain special precautions as listed below must be taken. While speed is essential, it is still true that "Haste Makes Waste". The introduction of contamination must be avoided at the point where a main is broken. Such contamination may be in the nature of human excreta as found in a sewage system and may readily cause pollution of the water supply when both water and sewer lines are broken in the same bomb crater.

A number of diseases are transmitted through drinking water: Typhoid, Cholera, Para-Typhoid, Bacillary Dysentery, Amoebic Dysentery, Gastro-Enteritis (Diarrhea) and others.

Human excreta is a carrier of Typhoid (Bacillus Typhosus). It is also a carrier of many harmless bacteria. The Typhoid organism may be found in sewage though there may be no actual cases of the disease in the community. There are human carriers of the disease, people who have recovered from Typhoid fever but who may carry the organism in its active state for months, years and perhaps the remainder of their lives. The waiter or cook in a restaurant may be such a carrier who can transmit the organism through the food you eat. People who are known to be carriers are controlled and regulated by the New York State Department of Health, but there are many such carriers who are unknown, therefore, not under control.

There is a cycle of transmission of disease. At the opening of this cycle is the actual case or carrier by whom the bacteria are deposited in sewage. Flies may carry the disease from the sewage, or the sewage may come in contact with a water supply or food. At the ultimate receiving end is the well person.

Cholera, at present no problem in this country, may become re-established through the fact that thousands of our soldiers are now in parts of the world where the disease may be prevalent. Dysentery

is transmissible through water; fatalities from it are frequent. Gastro-Enteritis is not serious in itself, but it may be a forerunner of typhoid or dysentery.

The potential danger of water borne outbreaks of disease is usually recognized, but human carelessness or complacency is responsible for disregard of this potentiality, thus causing epidemics.

Bombing, sabotage or excessive pumping during a fire may bring on pollution or contamination of water through back siphonage.

There are three general ways in which pollution can take place in a water system:

1. Back siphonage of pollution into water lines through defective plumbing fixtures or favorable hydraulic conditions set up in the system due to excessive use of water during fires, breaks in mains, closing of certain valves, etc.
2. Seepage of pollution into water lines after a break in a main has been valved off.
3. Blowing of pollution into water mains by force of explosion.

Listed below are three important precautions to be taken when a break in a main occurs:

1. Pollution must be assumed below and above a break. Sudden reduction of pressure at a faucet is the first warning of back siphonage. Aspiration of air at faucets is convincing evidence. *Drinking water should be boiled when these conditions occur.*
2. Cleaning, disinfecting and flushing of pipe on both sides of a break, including house services and the new section of pipe, should be carefully carried out. Disinfecting and flushing should be extended to the entire area affected by a break.
3. Even after the cleaning, disinfecting and flushing, the boiling of water should be continued until it is determined authoritatively that no bacteriological pollution exists in the water system. From 2 to 3 weeks may be required to destroy or remove pollution entirely. Filtration and chlorination in most instances is effective in removing the above mentioned organisms. However, chlorine alone, unless in very high doses, will not kill the organism causing amoebic dysentery.

CLASS LESSON NO. III

Relation of Water to Fire Protection

SYLLABUS FOR CLASS TRAINING SESSION NO. 3

2 Hours

Subject. Relation of water supply to fire protection.

Instructor. Instruction preferably should be given to a combined group of auxiliaries from all towns and villages in the county. An outstanding water works expert, fire chief, or engineer who has good knowledge of water supply fire requirements should serve as instructor.

Scope. *First hour:* Lecture on general aspects of the subject, flow requirements for various type fires, situations with respect to water supply which will exist in case of multiple fires, differences in situations with respect to water supply which will result from demolition and incendiary bombings, explanation of demolition and incendiary bombs and related matters. Use prepared charts or blackboard sketches to illustrate particular features and display models of bombs if obtainable.

Second hour: Discussion period and oral quiz followed by showing of motion picture "London Air Raid" or other similar motion picture obtainable upon request through State Office of War Training, 353 Broadway, Albany, New York.

Assign for reading prior to lesson No. 4 pages 82 to 124 of Bulletin No. 22 ("Water Supply Control") and Bulletin No. 33 ("Tests for Residual Chlorine and Ammonia") published by New York State Department of Health.

Reference Text for Lesson.

Before a person can really understand the problem of fire protection he must give some study to the subject of what constitutes fire and how fires can be extinguished.

Chemistry of Fire.

A brief description of the chemistry of fire is that it is a combination of combustible material with oxygen caused by the application of

heat and in itself producing more heat. Almost all materials will combine with oxygen under certain conditions. This includes some of the minerals, such as iron, but we are not particularly interested in the possible burning of the common metals found in commerce except under very unusual conditions, such as when they are being handled in a finely divided state or as a powder.

The combustible material which is involved in most fires is carbon in many forms. Ordinary wood is about 50 per cent carbon; it also contains considerable moisture and may have gums, resins and other ingredients, most of which have to be volatilized before they will combine with oxygen. The normal product of carbon in whatever form when it combines with air, is carbon dioxide gas which is an inert product, incombustible, odorless and heavier than air. Where there is not enough oxygen available, instead of two parts of oxygen combining with one of carbon, the product may be one part of oxygen with one of carbon, and this gas is known as carbon monoxide. It will burn, even with explosive violence, when mixed with the proper amount of air; in fact it is about the same as commercial gas. The oxygen used to make a fire is taken from the air, which normally is made up of 21 per cent of oxygen and the remainder nitrogen and other gases.

Three Ways to Control Fire.

There are three ways of controlling a fire. One is by removing the combustible material or by so separating the material that one portion burning will not spread to other parts. Another is to add inert gases to the air to a point where there is less than 15 per cent of oxygen remaining. It may be that all of the oxygen of the air can be kept away from the combustible material through the application of a cover or the spreading of a blanket over the burnable material. This blanket may be one composed of slow burning or incombustible material, such as one made of asbestos, or it may be a blanket of inert gas which is heavier than air and will settle around the combustible material.

The third and most effective means of extinguishing a fire is to reduce or eliminate the heat which is causing the chemical reaction. It is one of the nice balances of nature that the material which is most effective in absorbing heat and which is most easily handled is also one of the most abundant in the world. This material is water.

Amount of Water Needed to Extinguish Fire.

The great question in fire fighting is as to the amount of water necessary to extinguish a fire which involves a large amount of combustible material, as would be the case in connection with a burning building. Having determined this question the next item is how best to apply water to make it most effective. In considering the first question one must know something as to the amount of heat units liberated when material burns and the amount of heat units which can be absorbed by water. A pound of wood burning freely in the air gives off approximately 8,000 heat units. A pound of oil may produce up to 20,000 heat units. When a pound of water is heated from ordinary temperatures up to 212 degrees and then is turned into steam, it absorbs 1,000 heat units. From these figures you can see that for every pound of wood which is actually burning, either as incandescent embers or as flame, it will be necessary to use approximately one gallon of water before it can be cooled down to a point where it will be extinguished. When fire first starts it involves only the surface of wood or other burnable material, and with this surface burning it is obvious that even though it may extend over many square feet it has not not yet brought many pounds of burnable materials up to the ignition point and therefore a small amount of water can absorb all of the heat units evolved and thus extinguish the fire. This principle is recognized in the application of automatic sprinklers and in the use of chemical extinguishers and small hose. However, when a fire has been burning for a considerable period of time and the heat units evolved have been absorbed corresponding to one-half inch or more of charring, it is very obvious that water in large quantities must be used. Not only must it be in large quantities, but it must be delivered from a distance because of the inability of the men to withstand radiated heat, but the delivery must penetrate into the seat of the fire. Under these conditions it is obvious that a large percentage of the water discharged through hose or nozzles is wasted.

Value of Automatic Sprinklers.

In determining the amount of water needed for fire protection one of the first questions will be as to how quick after the fire starts can water be applied. Where a plant is under constant operation no fire should get a large start before some one discovers it. For that reason such buildings as pumping stations and power plants are seldom seriously damaged by a fire. There are exceptions to this

and for that reason it is unwise to use burnable material in any type of plant which serves the public and must be run continuously.

The value of automatic sprinklers, which today is recognized as an essential in many industries, is due to the fact that the fusible link in the sprinkler head or the thermostat controlling the sprinkler system is affected by the heat of the fire in the very early stages and long before combustible material in the structure of the building can become highly heated. On this basis automatic sprinklers are very successful with only a small flow of water as its basic requirement. For the light hazard building equipped with sprinklers, it is considered that a flow of 250 gallons a minute will be sufficient to take care of any ordinary fire. It may not actually extinguish all of the fire, but it will hold it in check, keep it from spreading, and cool down the gases of combustion to below the ignition temperature of wood or other combustible material. For the ordinary hazard occupancy a satisfactory supply of water is one delivering 500 gallons a minute. Where the occupancy is extra hazardous such as would be found in connection with the storage of material having a flash fire hazard, much greater quantities will be necessary because of the danger of more heads being opened and also the necessity of allowing the sprinklers to operate for a long time.

The Time Element in Fighting Fire.

Several attempts have been made to prepare a formula with which it would be possible to determine the quantity of water necessary to fight fires with hose streams in buildings of different sizes and different occupancies. The final conclusion was that no formula could be produced which would take into consideration the time element of discovery and that this was one of the most important facts in regard to large losses produced by fire. A study of many hundreds of fires indicates that this delay in the discovery of a fire, plus the almost universal use of stairways and elevators without enclosures, may readily permit the entire interior of a building to become charged with superheated gases. These superheated gases bake out the resins and other volatile material in wood and produce partially burned smoke and gases which will burn with great severity if enough air is admitted to the building. In addition the carbon in the wood will char and become incandescent for a considerable depth. Under these conditions all that is needed to make a raging fire is to allow enough oxygen through the breaking of a window or the opening of a door.

Water Capacity of Fire Pumpers.

One good fire stream, as used by a fire department, discharges from 300 to 350 gallons of water a minute. On a relatively small factory building or mercantile establishment four streams of water might be used which would mean a minimum of 1,500 gallons of water a minute. If the building is of considerable size and is of several stories, such that streams would be used from the street and on upper floors, through deck pipes and ladder pipes, the quantity of water which would be used increases very rapidly. A ladder pipe or turret nozzle discharges 600 to 900 gallons of water a minute.

With any of these larger fires there is an immediate danger of other buildings being involved through radiated heat or direct impingement of the flame. In the more closely built areas such as those found in the mercantile sections of a city, the question of the quantity of water needed really comes down to the item as to whether it can be concentrated on the buildings on fire. Friction loss in hose builds up very fast with the result that in even the larger cities it is seldom possible to concentrate more than about 12,000 gallons a minute on any building fire, including the exposed buildings.

One of the burdens put upon water departments has been the increased pumping capacity made available to fire departments through the use of automobile fire engines. In the days of the old steam fire engine it was seldom necessary to figure more than 500 gallons a minute, as the amount of water which would be used by each fire company. Today with automobile engines having capacities up to 1,250 gallons a minute, and a majority of them being of 750 gallons or greater capacity, it is obvious that the water department has a more serious problem than in the past. Through the use of these pumpers of greater capacity, and of turret nozzles, deck pipes, ladder pipes and siamese conections, the amount of water necessary for adequate protection will increase from time to time, and no water department can afford not to furnish all the water needed by the fire department. Additional emphasis has to be placed upon this duty of the water department, because of the fact that today much outside aid is available not only for conflagrations but for ordinary fires in individual buildings when these fires are of dangerous proportions. With reasonable speed any fire company within thirty miles may be able to respond in an hour's time.

Special Problem of Industrial Fire Protection.

A thorough study of our American cities and towns indicates a generally adequate supply of water in the business district. In the

older cities the manufacturing plants were grouped along the railroads and often fairly close into the center of the city, as at the time these plants were located transportation facilities made it necessary to place them where they could be reached with short travel from most any part of the city. It has been noted, however, these industrial plants were often very poorly protected from the standpoint of water supply. In many cases sufficient hydrants are not available, the water mains are old and often of inadequate size.

Industrial plants being erected today, because of the greater facility of getting to them by automobile, the need of providing parking space, and the present desire to build low buildings of large area rather than multi-storied buildings, is resulting in most of these industrial plants going up in the outlying parts of a city or outside the city limits. When these plants are erected, it often means extending a distribution main as a dead end for a considerable distance. Sufficient attention has not always been given to the need of fire protection in extending these mains. Obviously such a main to give even moderate protection should be larger than 6 inch, as a 6-inch line for 1000 gallons flow gives a friction loss of 52 pounds for 1000 feet of pipe. Even an 8-inch line, 1000 feet long, can deliver only a little more than 2000 gallons a minute with a friction loss of 50 pounds. When it is realized that this 2000 gallons a minute is only about six good streams, and that it could not supply three 750-gallon pumpers, it can be seen that a plant of any considerable size containing readily burnable values cannot be protected by an 8-inch line 1000 feet long and even if the distance is only 500 feet, the total supply available with any ordinary pressure of 50 to 60 pounds would be only about 3000 gallons a minute. Twelve-inch pipe is the minimum which should be used to supply any considerable industrial enterprise. If it can be looped, an adequate supply for most any industrial plant would be available, providing the 12-inch main is well fed at the two ends. This is true even though one side of the loop is 1000 feet long.

Limitations of Booster Pumps.

There are many water works men who recognize the inability of long single lines of 6- and 8-inch pipe to furnish adequate fire protection, and who have the idea that by installing booster pumps which can increase the pressure at time of fire this situation can be corrected. This belief is not substantiated by actual test nor by calculations. A slight increase can be obtained but not enough to really

constitute a satisfactory amount for fire protection. As an instance of this, assume a building located in the outskirts on the end of 3000 feet of 8-inch pipe with approximately 40 pounds static pressure. The maximum amount of water which a fire engine could obtain at this plant would be approximately 1000 gallons. Putting a pump midway on this line would increase the quantity available to a total of 1500 gallons. No more water could be delivered irrespective of the pressure carried at this point because of the limited capacity of the line to the suction side of the pump. If instead of locating this booster station midway between the gridiron system and the plant, suppose the pump was located at the point where the 8-inch line took off from the gridiron. By designing the pump to operate at 80 pounds pressure, 1500 gallons could be obtained, or by carrying 140 pounds pressure, 2000 gallons could be delivered. Probably the most ideal location for the booster pump would be at a place one-fourth the distance from the gridiron to the plant. At this location 2000 gallons of water could be obtained with pumps of that capacity designed for 100 pounds pressure. Although increasing the flow, by at least 3 additional streams, if this plant is large and contains high values and a moderate amount of combustible material in its structure, it is obvious that a total delivery of 2000 gallons would not result in putting the fire out if there had been considerable time between its inception and its discovery.

A room containing only 1200 square feet of wall, ceiling and roof surface if allowed to char ¼ inch thick would use up all of the heat reduction qualities of 1000 gallons of water a minute, but of course if this amount of water was used continuously on such a building, and was so moved about that it would reach all parts of the material which was burning, it would readily cool it down to a point where the fire would go out. The unfortunate part is that in fire fighting the amount of smoke, the inability to hit all portions of the building through fire streams through windows and doors, and the fact that the fire might be burning at a point where no attempt was being made to use a stream, all add up to the thought that an excessive amount of water will be wasted and that the water department must supply much more than any theoretical quantity that might be worked out if the larger plants and buildings are to be protected against destruction by fire.

Suction Storage Reservoirs for Emergency Protection.

One of the outstanding facts which has showed up in connection with studies made of civilian defense is that many industrial plants

are seriously deficient in protection other than that furnished by automatic sprinklers, and if the automatic sprinklers are out of commission there is no question but that the plant will be completely destroyed by even a fire of moderate proportions. As indicated above it takes a large delivery of water to furnish enough protection for these plants, and at the present time there is such a shortage of pipe of all kinds that some other arrangements must be made to provide the necessary hose stream protection for most of the industrial plants of the country. The most reasonable scheme is to build suction storage reservoirs and to arrange either for the fire department to use these by dropping the pump suction into the reservoir, or for the plant to install pumping equipment which can deliver water through pipe or hose to points where it can be used effectively in the building. To provide for reliability it is suggested that the pumps for these suction supplies be operated by internal combustion engines, and that instead of installing one machine of 1500 gallons capacity it might be better to install three small ones of 500 gallons capacity. The gasoline engine driven pump using an automotive type of engine and a centrifugal pump has proven very satisfactory for protection of municipalities by the fire department. There is no reason to assume that equal care cannot be given to this equipment if it is part of the private protection of a plant and therefore no reason why these small automotive type engines with centrifugal pumps cannot render satisfactory service for plant protection. Installation of machines of this kind is not expensive.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 3

To be reproduced locally for distribution to all Class Members

Relation of Water to Fire Protection

Fire as it is commonly known is the chemical combustion of oxygen with combustible material. It is true that nearly all materials will combine with oxygen under favorable conditions.

Carbon is the element most commonly involved in fires, and combines most readily with oxygen. The usual product of this combustion is carbon dioxide. When there is insufficient oxygen available, the resulting product is carbon monoxide which may later burn with explosive force to form carbon dioxide.

There are three ways of controlling a fire:

1 By removing combustible material or by so separating it that the burning portion will not spread the fire.

2 By applying inert gases and in this way reducing the oxygen content of the surrounding atmosphere to less than 15%. Sometimes it is possible to keep all oxygen away by covering the combustible material with a slow burning or incombustible cover or blanket made of asbestos, for instance. It might be a blanket of inert gas heavier than air which will settle around the combustible material.

3 By reducing or eliminating the heat of chemical reaction through the use of water.

The time elapsing between the start of a fire and the application of water to it determines greatly the volume of water needed for extinguishment. Automatic sprinklers are effective in controlling a fire in its early stages. But no effective formula has yet been devised by which to determine the quantity of water necessary to extinguish fire in buildings of varying size and occupancy. In such cases the time element would again be the unknown quantity.

A good fire stream as used by a fire department can supply from 300 to 350 gallons of water per minute. A ladder pipe or turret nozzle supplies 600 to 900 gallons per minute.

It is more important to know the necessary volume of water in a community where supplies are limited than in a community where supply is bountiful. Modern fire equipment has a higher capacity of supplying water than the old steam fire engine. Consequently, water departments today are harder put to it to provide the water in efficient quantity.

It is true that American cities for the most part have adequate water supplies, and yet it has been found that the industrial districts of the older cities are not yet sufficiently supplied because of old water mains of small diameter and insufficient numbers of hydrants.

Many water works men are aware that long single lines of 6″ and 8″ pipe are inadequate in supplying sufficient water to a large plant in time of fire. Many of these same men believe that booster pumps can increase the supply sufficiently by furnishing additional pressure. Actual tests have disproven their belief. True, an increase is obtained but not in important quantity.

Water departments must supply a far greater volume of water than is theoretically necessary in the case of protecting larger plants and buildings against fire.

Studies and surveys have shown that many industrial plants are deficient in protective equipment supplemental to sprinkler systems. Shortages of pipe of all kinds make it necessary to arrange some other means of supply. A combination system of reservoirs and gasoline engine suction pumps, located in strategic places can be satisfactorily arranged at relatively low cost.

CLASS LESSON NO. IV

The Emergency Chlorination of Water

SYLLABUS FOR CLASS TRAINING SESSION NO. 4

2 Hours

Subject. Chlorination and tests for residual chlorine.

Instructor. Instruction preferably should be given to a combined group of auxiliaries from all towns and villages in the county. An outstanding water treatment plant operator or superintendent should serve as instructor.

Scope. *First hour:* Lecture on the purposes and theory of the chlorination process, chlorine demand, chlorinator equipment of various types, and both the starch iodide and orthotolidine tests for residual chlorine. Use prepared charts or blackboard sketches to illustrate particular features.

Second hour: Discussion period, oral quiz and demonstration of chlorine demand test, starch iodide and orthotolidine tests.

Assign for reading prior to lesson No. 5, New York State Department of Health mimeographed bulletin entitled "Manual of Emergency Sanitation Services."

Reference Text for Lesson.

The difference between normal and routine chlorination of potable water supplies and the emergency chlorination of water should be emphasized when instructing auxiliary personnel. This is important because many of the refinements of conventional chlorination need not be followed during emergencies.

Importance of Operation.

The disinfection of water with chlorine is only effective when chlorine is added in adequate quantities to *every portion of the supply.* Stress should be placed therefore upon the maintenance of *continuous* operation; so supervision is frequently more important than the character of the equipment being used. Stress also should be placed upon the fact that any interruptions in chlorination will result in the immediate delivery of an unsafe water, so that pumps should

be stopped or valves should be closed on gravity supply mains whenever there is an unavoidable interruption in chlorination and pending repairs of the equipment. Records should be kept as to operation details.

The Action of Chlorine in Water. Chlorine is a very active chemical which combines very rapidly with organic matter when added to water. It is necessary therefore to add a surplus of chlorine so that sufficient will be present to react with the organic matter and yet leave a surplus or residual to act as a disinfectant on the bacteria.

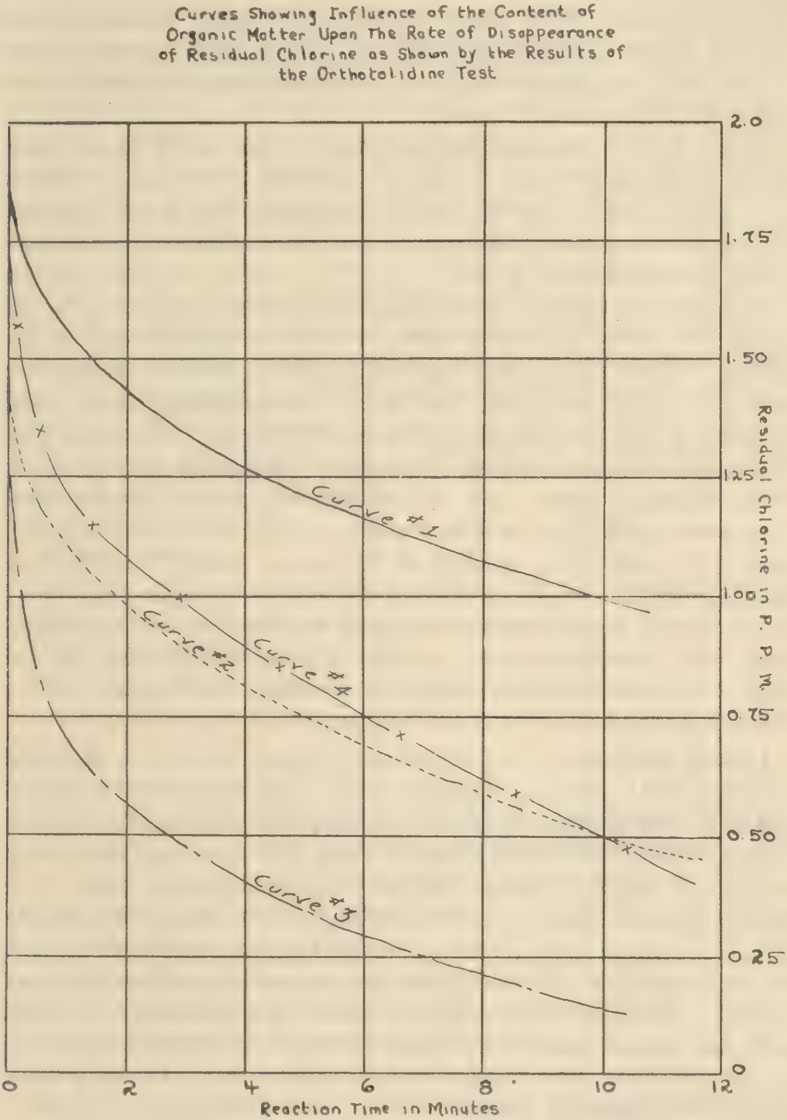
The reaction between chlorine and organic matter is very rapid at first, but subsequent reactions between the remaining residual chlorine and the organic matter are much slower as indicated by the gradual disappearance of residual chlorine from treated water. These reactions also are more rapid with higher water temperatures.

The amount of chlorine which reacts with organic matter in water has been termed the *chlorine demand* of the water. The chlorine demand therefore represents the difference between the dose of chlorine and the concentration of residual chlorine. For instance, if a dose of one part per million gives a concentration of residual chlorine of 0.2 p.p.m. after a 10 minute reaction period, the 10 minute chlorine demand of the water is a difference between 1.0 and 0.2 or 0.8 p.p.m. Inasmuch as the organic content and the temperature of water varies to a considerable extent, the chlorine demand of the water likewise varies. It is impossible to measure the chlorine demand directly, so the procedure is to add sufficient chlorine to give the desired concentration of residual chlorine as determined by the orthotolidine test. The standard procedure is to determine the concentration of residual chlorine remaining after a 10 minute reaction period.

Inasmuch as lower residuals would prevail with longer reaction periods, there will be a corresponding increase in the chlorine demand with longer reaction periods. For this reason the chlorine demand is not a fixed value for any given water but varies with the time of contact and the dose of chlorine actually used. To summarize therefore the chlorine demand is stated in terms of dose of chlorine less the concentration of residual chlorine after a stated reaction period. The above values for example would be stated as a 10 minute chlorine demand of 0.8 p.p.m. with a dose of 1.0 p.p.m.

The directions for making the orthotolidine test will be described later. The principles underlying the use of the test will be illustrated

by referring to the accompanying curves which should be reproduced on the blackboard when discussing the subject with auxiliaries.



These curves have been based upon assumed conditions prevailing during an emergency when an auxiliary water supply is being so

chlorinated as to produce a residual of 0.5 p.p.m. after a 10 minute reaction period.

Curve No. 1 illustrates results secured by the dose of 2 p.p.m. producing a residual of approximately 1.0 p.p.m. after the 10 minute reaction period. This curve therefore represents results secured when a higher than the necessary dose of chlorine was added, that is the dose was greater than the 10 minute chlorine demand plus the desired residual of 0.5 p.p.m.

Curve No. 2 illustrates the case where a dose of 1.5 p.p.m. when added to the same water produced a residual of 0.5 p.p.m. after a 10 minute reaction period, which represents the desired results, because the dose was just equal to the chlorine demand, 1.0 p.p.m. plus the residual of 0.5 p.p.m.

Curve No. 3 illustrates the situation where the same dose of 1.5 p.p.m. was added to a water having a higher organic content or one having a higher temperature than with curve 2, whereby the chlorine demand was greater, which led to a correspondingly more rapid decrease in the concentration of residual chlorine. Therefore only 0.15 p.p.m. residual chlorine remained at the end of the 10 minute reaction period rather than the desired 0.5 p.p.m. Under these circumstances the chlorine dose would have to be increased to approximately 2.0 whereby a residual of 0.5 p.p.m. would be secured as shown by curve No. 4. It is evident from the "steepness" of curve No. 4 that the higher chlorine demand is leading to a correspondingly more rapid disappearance of residual chlorine, but in this case the dose was sufficiently high to give a residual of 0.5 p.p.m. with a chlorine demand of 1.5 after a 10 minute reaction period.

Liquid Chlorine. The properties of liquid chlorine is discussed in Lesson 10. This gas liquefies when it is compressed into steel cylinders and small volumes of the liquid in conveniently handled cylinders weigh 100 to 150 pounds. Thus it is convenient to disinfect large water supplies through the use of liquid chlorine. There is no inert material, so doses may be computed on the basis of the weight of liquid chlorine used. Thus a dose of 1 p.p.m. is secured through the application of 8.34 lbs of the gas per million gallons of water treated. The cylinders should be shielded from excessive heat and cold, and special precautions should be taken to maintain tight connections between the cylinder and the chlorinator. Other precautions are discussed in Lesson 10.

Chloride of Lime. Chloride of lime, also known as "bleach" or "calcium hypochlorite," is extensively used for many purposes during the war emergency and thus cannot be secured so readily. Twelve

ounce cans of the material, however, are sold in groceries and drug stores and are convenient for the emergency chlorination of small water supplies. Ten pound cans and larger drums of chloride of lime may be secured from janitor and milk plant supply houses, provided priorities restrictions are met by filing an affidavit with the supplier to the effect that the material is to be used for *potable* water treatment.

Chloride of lime contains up to 33 to 37 per cent chlorine by weight but loses strength upon storage, especially during summer weather and after the cans are opened. It is best to assume that the material contains 25 per cent chlorine by weight; that is, that one pound of chlorine will be present in each four pounds of the powder. The powder absorbs moisture from the atmosphere and so should be stored in a dry cool place in tight containers.

Chloride of lime consists of a mixture of lime and the active chlorine compound. Solutions of the material therefore contain insoluble lime which has no disinfecting value and the soluble chlorine compound. Special instructions therefore should be given as to the preparation of solutions so that insoluble sludge will not clog the chlorinators. The following instructions are suggested:

Equipment:

- *a* Barrel, stoneware crock, or large milk can in which to dissolve the chloride of lime.
- *b* Wooden mixing paddle.
- *c* Rubber tube to act as siphon when needed.
- *d* Scales.

Procedure:

1. Add a small volume of water to the required weight of chloride of lime needed for a specific purpose so as to prepare a thin paste, which should be thoroughly mixed to break up lumps.
2. Dilute the paste with sufficient water to fill the mixing tank and thoroughly mix.
3. Allow the lime sludge to settle, and pour or siphon the clear supernatant liquid into the solution tank, barrel, crock or bottle of the chlorination equipment.

H.T.H. and Perchloron. These two compounds are practically pure calcium hypochlorite, which is much more soluble than chloride of lime. They are quite stable and it may be assumed that they contain 70% available chlorine by weight. Unfortunately, practically the total available supply of these disinfectants is being used by the

armed forces, so that they are not generally available for the emergency chlorination of public water supplies.

Solutions may be prepared as noted above for chloride of lime, except it is possible during emergencies to prepare the solutions directly in the solution tank rather than a separate mixing tank. One 3¾ pound can of H.T.H. or Perchloron will make 30 gallons of solution containing 1% (10,000 p.p.m.) available chlorine. Here

Table No. 1, Illustrating Weight of Chloride of Lime, H.T.H. and Perchloron Required to Prepare Stated Volume of 1.0 Per Cent (0.01) Solution.

Volume of Solution in Gallons	*Weight of 25% Strength Chloride of Lime Required*		*Weight of 70% Strength H.T.H. or Perchloron*	
	Pounds	*Ounces*	*Pounds*	*Ounces*
1	0	6	0	2
5	1	12	0	10
10	3	5	1	3
20	6	7	2	6
30	10	0	3(3¾#)	9
40	13	5	4	12
50	18	5	5	15

Note: Weights are figured to the nearest ounce.

again auxiliaries and volunteers should be furnished simple written directions as to the amount of material which must be used in the preparation of solutions used in treating any specific supply.

Sodium Hypochlorite. Sodium hypochlorite solutions, also known as liquid bleach, may be purchased in drug stores, grocery stores, and janitor and milk supply houses under a variety of trade names. The solutions are manufactured in most large communities and may be purchased most economically in three and five gallon bottles rather than the smaller containers sold in drug and grocery stores. Zonite, sold in drug stores as a medicinal product, contains 1% available chlorine *by weight*. Most solutions sold in grocery stores under a variety of names contain about 5% available chlorine by weight. The strength is noted on the label. Solutions sold by janitor and milk supply houses in larger containers usually have a strength of 14% available chlorine by weight.

Computing Required Doses of Chlorine or Chlorine Compounds. Most auxiliaries and volunteers will have difficulty in computing chlorine doses, so that simplified tabulated directions should be provided for their guidance based upon the specific supply being subject to emergency chlorination. Do not expect them to be able to compute doses of chlorine for varying conditions other than those for which they have received special instructions.

Suggested procedure for computing chlorine doses is based upon simple tabulations, the use of which will be explained. General formulae are given for computing tests under varying conditions when the tabulation may not be adequate. It should be emphasized that auxiliaries and volunteers will only be confronted with rather restricted ranges in flow of water being treated and as to the disinfectant being used, so that practical instruction will be simplified by restricting the computations to these specific conditions.

Table 1 gives the weights of chloride of lime with assumed strength of 25% available chorline and also the weights of H.T.H. or Perchloron with a strength of 70% of available chlorine by weight which are required to prepare a stated volume of 1% chlorine solution, which strength is quite convenient for use with hypochlorite feeders. For instance, 10 gallons of 1% strength solution may be prepared by adding 5 lb. 3 oz. of chloride of lime, or 1 lb. 3 oz. of either H.T.H. or Perchloron to that volume of water. Note especially that 30 gallons of 1% solution may be prepared by adding 10 lbs. of chloride of lime or 3¾ lbs. of either H.T.H. or Perchloron. These weights represent the contents of convenient size cans of the disinfectants, so scales are not needed to weigh the material used in preparing 30 gallons of solution. Earthenware crocks of this capacity are available or 30 gallons of solution may be prepared in a barrel.

Table 2 gives the amount of the 1% solution so prepared, which is required for the disinfection of the volumes of water noted. For instance, water flowing at the rate of 100 gallons per minute, or 144,000 gallons per 24 hours, could be disinfected through the application of 13 gallons 6 pints of 1% solution per 24 hours. In this instance the solution would be applied by the chlorinator at the rate of 1 gallon in 208 minutes, as indicated by the rate under Column 4 of Table 2. This column is useful in checking the operation of emergency chlorinators, because the rate of drop of the surface of the chlorine solution in the container may be timed.

The basic figure to keep in mind for the use of 1% solution is that one gallon of the solution will provide a dose of 1 p. p. m. to 10,000 gallons of water. Thus 5 gallons of the solution would treat 50,000 gallons of water with a dose of 1 p. p. m.

Table 2 may be used conveniently for volumes of treated water other than actually noted in the table. For instance, water flowing at the rate of 350 gallons per minute naturally would require three and a half times the amount of solution required for the treatment of water flowing at the rate of 100 gallons per minute,

Table No. 2, Illustrating Volume of 1 per cent Strength Hypochlorite Solution Required per 24 hours and Rates of Flow of Solution Needed to Provide a Dose of 1.0 p.p.m. When Treating Water Flowing at Rates of 50 to 1000 Gallons per Minute.

Rate of Flow of Treated Water		*Total Quantity of 1 per cent Solution Required per 24 Hours*		*Rate of Flow of 1 per cent Solution Time Required for Flow of 1 Gallon or 8 Pints*	
Gallons per Minute	*Gallons per 24 Hours*				
50	72,000	6 gallons	7 pints	208 minutes	0 seconds
100	144,000	13 gallons	6 pints	104 minutes	0 seconds
200	288,000	27 gallons	4 pints	52 minutes	0 seconds
300	432,000	41 gallons	2 pints	34 minutes	40 seconds
400	576,000	55 gallons	0 pints	26 minutes	0 seconds
500	720,000	68 gallons	6 pints	20 minutes	48 seconds
700	1,000,000	96 gallons	2 pints	14 minutes	52 seconds
1,000	1,440,000	137 gallons	4 pints	10 minutes	24 seconds

Note: 1 gallon of 1 per cent solution gives a dose of 1.0 p.p.m. to 10,000 gallons of water.

namely 3½ times 13 gallons and 6 pints equals 385 pints or 48 gallons and 1 pint.

Sodium hypochlorite solutions only need be diluted to the desired strength. Household bleaches containing 1% to 5% available chlorine are suitable for treating small volumes of water, but the 14% strength solution ordinarily is used in treating public water supplies.

The required volume of diluting water must be computed by including the volume of the stock solution as part of the volume of the final diluted solution. For instance, 14% strength solution

diluted to 1% strength would require the use of 1 part of stock solution and 13 parts of water to give 14 parts of dilute solution of 1/14 the original strength. *Do not* add one part of the stock solution to 14 parts of water.

Table No. 3, Illustrating Volume of Stock Sodium Hypochlorite Solutions Needed to Prepare Stated Volume of Dilute Solution Containing 1.0 per cent Available Chlorine by Weight.

Strength of Stock Sodium Hypochlorite Solution (See Label)	Volume of Dilute Solution to be Prepared (1.0 per cent available chlorine)							
	5 gallons		30 gallons		50 gallons		100 gallons	
	Vol. Dil. Water	Vol. Stock Sol.	Vol. Dil. Water	Vol. Stock Sol.	Vol. Dil. Water	Vol. Stock Sol.	Vol. Dil. Water	Vol. Stock Sol.
1	0	5	0	30	0	50	0	100
2	2½	2½	15	15	25	25	50	50
3	3⅓	1⅔	20	10	34	16	66⅔	33⅓
4	3¾	1¼	22½	7½	37½	12½	75	25
5	4	1	24	6	40	10	80	20
10	4½	½	27	3	45	5	90	10
15	4⅔	⅓	28	2	46⅔	3⅓	93⅓	6⅔

Note: Add one part of 14% strength stock solution to 13 parts of water to give 14 parts of 1% solution.

Table 3 is based upon this fact. For instance, 6 gallons of 5% sodium hypochlorite solution would be diluted with 24 gallons of water to give 30 gallons of 1% solution.

Formulae: Emergencies may arise where Tables 1 and 2 are of limited assistance, in which case the weight of chlorine compounds required for the disinfection of known volumes of water with desired doses of chlorine may be computed by the use of Formula No. 1:

1 Pounds of Chlorine Compound (Powder) =

$$\frac{\text{Gal. Water Treated x Desired Dose p.p.m. x 8.3}}{\text{\% Strength of Compound x 1,000,000}}$$

The per cent of the chlorine compound should be expressed as a decimal. Thus 25% chloride of lime would have a strength of 0.25, because 25% means 25 per 100 or $\frac{25}{100} = 0.25$.

The strength of solution prepared in this way would be computed by Formula No. 2 as follows:

2 Percent Strength Solution =

$$\frac{\text{\% Strength of Compound x Pounds of Compound}}{\text{Gallons of Solution x 8.3}}$$

In this case also the percent of strength of solution is expressed as a decimal value. For instance a 1% solution would be expressed as 0.01.

It may be desirable to compute the gallons of solution required for specific conditions. Two formulae are available for this purpose.

3 Gallons of Solution =

$$\frac{\text{Dose in p.p.m. x Gallons Water Treated}}{\text{\% Strenght Solution x 1,000,000}}$$

Formula 3 gives gallons of solution required for a stated dose, the gallons of water treated and the percent strength of solution. This formula, therefore, gives the amount of a given percent strength of solution required for the treatment of a given volume of water.

4 Gallons of Solution =

$$\frac{\text{\% Strength Compound x Pounds of Compound}}{\text{\% Strength Solution x 8.3}}$$

Formula 4, however, gives the amount of water which is needed to prepare a solution of any desired strength when a given number of pounds of chlorine compound of known strength is used.

The *weight of available chlorine* in any given volume of solution of known strength may be computed by formula 5:

5 Pounds of Available Chlorine = Gallons of Solution x % Strength of Solution x 8.3

The dose of chlorine applied may be computed from gallons of solution used of known strength and the volume of water treated by using formula 6. Note that this is formula 3 transposed.

6 Dose in p.p.m. =

$$\frac{\text{\% Strength solution x Gallons Solution used x 1,000,000}}{\text{Volume of Water Treated}}$$

The use of these tables and formulae will be illustrated by an example based upon the assumption that an emergency supply is pumped at the rate of 200 gallons per minute or 288,000 gallons per 24 hours and that a dose of 2.0 p.p.m. is estimated to be necessary to give a desired concentration of residual chlorine of at least 0.5 p.p.m. in the treated water. It is also assumed

that chloride of lime of 25% strength is used to prepare a 1% strength solution in a barrel of 50 gallons capacity.

Table 1 shows that 50 gallons of 1% solution is prepared by adding 18 lbs. 5 ozs. of chloride of lime with an assumed strength of 25% available chlorine by weight. Therefore, this weight of chloride of lime powder would be mixed into a paste with a small volume of water and the paste then diluted in a separate mixing tank or directly in the 50 gallon barrel.

Table 2 indicates that water flowing at the rate of 200 gallons per minute requires the application of 27 gallons 4 pints of 1% strength soultion per 24 hours for a dose of 1.0 p.p.m., so twice as much or 55 gallons of solution would be needed. Therefore, the 50 gallons of solution prepared as above would last slightly less than 24 hours so the chlorinator would be adjusted accordingly. Most portable hypochlorite feeders of the pulsating diaphragm type have a maximum capacity of about 75 gallons per 24 hours. Such a feeder would be adjusted to operate at about two-thirds capacity for the assumed conditions. The unit would be operated until the treated water could be tested for the concentration of residual chlorine actually present. If the residual was considerably greater than 0.5 p.p.m. the chlorinator would be adjusted so as to apply less solution, or conversely the dose would be increased if necessary.

Formula 1 would be used under the same circumstances as follows:

$$\text{Pounds of chloride of Lime} = \frac{288{,}000 \times 2.0 \times 8.3}{0.25 \times 1{,}000{,}000} = \frac{4{,}780{,}800}{250{,}000} = 19.1 \text{ lbs}$$

The strength of solution prepared by adding 19.1 pounds of 25% strength chloride of lime to 50 gallons of water would be computed as follows by using formula 2:

$$\text{Percent Strength of Solution} = \frac{0.25 \times 19.1}{50 \times 8.3} = \frac{4.77}{415} = 0.0115 \text{ or } 1.15\%$$

Trial use of this solution may indicate that it is being applied at the rate of 35 gallons per 24 hours. The actual dose applied may be computed by formula 6 as follows:

$$\text{Dose in p.p.m.} = \frac{.0115 \times 35 \times 1{,}000{,}000}{288{,}000} = 1.4 \text{ p.p.m.}$$

This value could be computed more simply by the relationship between the volumes of solutions involved. Thus:

$$\frac{35}{50} \text{ of } 2.0 \text{ p.p.m.} = 1.4 \text{ p.p.m.}$$

Summary. To illustrate the application of the above instruction, let us assume that a portable water-operated hypochlorinator is to be used to force diluted hypochlorite solution into the suction hose of a fire pumper which is being used during an

emergency to pump water from a creek through a fire plug into a distribution system. The pumper is assumed to have a capacity of 500 gallons per minute, or 720,000 gallons per 24 hours. The fire engine would be driven to a low point so the suction hose could be lowered into the creek at a point where a small pool of water may exist or where the bottom material could be excavated so as to submerge the end of the suction hose under 18 to 24 inches of water.

The portable chlorinator would be connected to a fitting on the discharge of the pumper to secure water under pressure to actuate the unit, or it would be connected to the hydrant or any other available tap. The end of the suction hose of the chlorinator would be inserted in the solution tank, such as a 30 gallon crock. The discharge hose of the unit would be inserted in the lower end of the suction hose of the pumper so that chlorine solution would be mixed with water entering the suction hose. In this way it is not necessary to cut out a hole in the suction hose nor to use any special fitting.

As in the previous example, Table 1 would be consulted and would indicate that 10 lbs. of chloride of lime would be used to prepare the 30 gallons of solution in the crock.

The fire engine would be started in operation to pump to waste and the chlorinator would be adjusted so as to inject approximately 30 gallons of the solution per 24 hours. The water so chlorinated would be tested with the orthotolidine reagent to determine whether or not 0.5 p.p.m. residual chlorine were present. After the unit is shown to be functioning satisfactorily, the valve of the fire plug would be opened and chlorinated water would be forced into the distribution system. The orthotolidine test should be repeated immediately because the opening of the hydrant valve and the closing of the waste valve would cause the pumper to operate against pressure which in turn would decrease its capacity; that is, the amount of water treated. The operator should be instructed to repeat the orthotolidine test at least once each hour so that proper adjustments may be made to the chlorinator to insure the presence of at least 0.5 p.p.m. residual chlorine. Note that no computations are needed for such adjustments. Records should be maintained for reference purposes.

Tests for Residual Chlorine.

The control of the chlorination of water through the use of tests for residual chlorine is discussed in bulletin No. 33 of the

New York State Department of Health entitled "Tests for Residual Chlorine and Ammonia." The emergency chlorination of water and the disinfection of water mains and other structures coming in contact with the water present different problems which warrant modifications in the usual test for residual chlorine.

It is necessary, therefore, to consider the special problems which present themselves with emergency chlorination and to outline simple procedures which are available.

Orthotolidine Test.

Purpose. The orthotolidine test for residual chlorine is intended to indicate whether sufficient chlorine has been added to the water to react with organic matter and other chlorine consuming materials and yet leave a surplus or *residual* which will remain in the water as a disinfectant for an appreciable period of time.

Principles. The orthotolidine test is based upon the fact that the orthotolidine reacts with chlorine to form a yellowish substance, the intensity of the color of which is proportional to the amount of residual chlorine reacting with the reagent. This color, however, is produced only when the sample is acid, so the orthotolidine reagent contains acid for this purpose.

Sampling Point. Usually the consumption of water varies between ten thousand to many million gallons of water per day. Each glassful of this water must be effectively chlorinated to insure satisfactory results. Too much reliance, therefore, cannot be placed in the single small sample of water as representing the whole supply. Special care must be exercised in the selection of the sampling point and in the collection of the sample. Most definite results are secured when the sample is collected close to the point where the chlorine is added to the water supply but sufficiently far below the point of treatment to insure adequate mixing of the chlorine in the water. Typical sampling points would be faucets on the discharge pipe of a pump where chlorine is introduced into the suction pipe, or a faucet on the gravity pipe line 50 to 100 feet below the point of application of chlorine. If a sample is collected too far from the point of treatment there will be no definite knowledge as to how long the chlorine has been in the water as sampled. Therefore, the collection of samples of water from faucets on the distribution systems should only be used for secondary purposes rather than in the control of the emergency chlorination.

Reaction Period. Inasmuch as the disinfection of water requires an appreciable period of time, and preferably 10 minutes before the water reaches the first consumer, the dose of chlorine should be sufficient to result in residual chlorine being present for at least 10 minutes. Therefore, the sample of chlorinated water is allowed to stand in the sampling bottle until a reaction period of 10 minutes has elapsed before the concentration of residual chlorine is determined by the addition of the orthotolidine reagent. This 10-minute period should include the time required for the chlorinated water to flow from the point of treatment to the point where the sample is collected. If this is estimated to be one minute then the sample should be allowed to stand 9 minutes in the bottle. The only exception to this specified reaction period is when samples are collected directly from faucets on distribution systems remote from the point of treatment and where the concentration of residual chlorine in the water as sampled is sought.

Orthotolidine Test Equipment. The equipment for making the orthotolidine test ordinarily may be purchased from firms listed in Bulletin 33 or may be homemade in accordance with directions given in that bulletin. The more elaborate and desirable testing kits using glass discs as color standards, or commercially prepared and stable color standards, are somewhat difficult to secure under war conditions. The supervision of emergency chlorination of water, therefore, usually requires the use of homemade equipment consisting of several empty two-ounce or 50 ml. French square bottles and a supply of orthotolidine solution, together with liquid color standards placed in the same type of bottle and prepared as described in Bulletin 33. Auxiliaries and volunteers should be instructed in the care and use of this simple equipment. The following points should be stressed:

1 Store the equipment in a clean, dark box or drawer when not in use.
2 Clean the sample bottle or tube by flushing with the water being sampled *each* time the test is made.
3 Let water run through the sampling faucet for a minute or so before collecting a sample.
4 Be sure and let the sample stand for 10 minutes *before* adding the orthotolidine solution.

Orthotolidine Test Procedure.

1 Fill the special test tube or collect in a 2-ounce French square bottle a 50 ml. sample of the chlorinated water at

a point near the application of the chlorine, but where the chlorine has been thoroughly mixed with the water.

2 Allow 10 minutes for the reaction period. Warm cold water by holding the tube or bottle in the hand.

3 Add 20 drops or 1 ml. of the orthotolidine solution to the sample and mix thoroughly. Do not use a solution that is colored or turbid.

4 Allow the sample to stand 5 minutes in the dark. This is in addition to the 10-minute reaction period noted in step 2.

5 Compare the resulting color with the standard solution and record the results of the tests as parts per million residual chlorine.

Usually the regular chlorination of public water supplies is controlled through the use of color standards equivalent to 0.1 and 0.2 p.p.m. residual chlorine and the chlorine dose is adjusted so as to maintain residuals in this zone. As stated previously the emergency chlorination of water justifies the use of 0.5 p.p.m. residual chlorine as the minimum value.

Interfering Substances. Bulletin 33 discusses methods of compensating for errors due to interfering substances, such as manganese, nitrates, color and turbidity of the water. This refinement, however, ordinarily does not influence the control of the emergency chlorination of water because the higher doses of chlorine being used provide the necessary factor of safety. There is no need, therefore, to discuss these refinements with the auxiliaries.

The Starch Iodide Test.

The orthotolidine test is quantitative because color standards are available and definite results are thereby secured. No standards are available, however, for the starch iodide test and thus it is not being used in the routine control of chlorination. There may be many emergencies, however, when water mains and other structures must be disinfected even though the supply is not chorinated, and where equipment for making the orthotolidine test may not be available locally. Under these circumstances the neutral starch iodide test may be made in accordance with the following directions, with solutions prepared locally.

Principles. The principle of this test is that residual chlorine reacts with the reagents and produces a blue color, the intensity of which is roughly proportional to the concentration of residual

chlorine. A faint blue color represents a concentration of residual chlorine between 0.1 and 0.2 p.p.m., whereas a dark blue color would represent a concentration of residual chlorine of several times these values. A blue-black color would represent a still higher concentration. Emergency chlorination should be so controlled that the residual is sufficient to produce with the starch-iodide a depth of color ranging from dark blue to blue-black.

Chemicals

1 Potassium iodide crystals or powdered form. (Can be purchased at any drug store.)

2 Starch solution. This can be prepared by any druggist or qualified chemist as follows:

Take 1 gram (15 grains) of clean starch (preferably arrow-root starch, obtainable at any drug store) and mix with enough cold water to produce a thin paste. Pour about 200 ml. (6 oz.) of boiling water into this paste, stirring thoroughly. Boil for a few minutes. This solution may be preserved by adding a few drops of chloroform, but a fresh solution should be made at least every two weeks or more frequently to give the best results. If scales are not available, ¼ teaspoonful of starch to 1 cup of water will give approximately correct proportions.

Equipment

Two 2-oz. French square bottles. Test tubes, tumblers, or other types of clear glass bottle will serve if these are not available.

Procedure

1 Pour into the empty bottle 50 ml. (fill to shoulder of bottle) of the chlorinated water to be tested, taken at a point near the point of application of the chlorine but far enough away to provide opportunity for the chlorine to mix with the water before the sample is collected.

2 Allow the sample of chlorinated water to stand 10 minutes after collection.

3 Add the following chemicals *in the order given:*

(a) Three to five crystals of potassium iodide, or if powder is used, an amount that can be taken on tip of knife blade.

(b) Two to five drops of starch solution.

4 Shake sample thoroughly after adding the above reagents.

5 Avoid exposure to direct sunlight.

6 Hold the bottle over a white surface and look down through it.

7 The color observed immediately after the reagents are added should be recorded. Any increase of color intensity upon longer standing should be disregarded.

Note: If, owing to the natural color or the turbidity of the water, it is difficult to recognize the blue color, the second bottle should be filled to the same depth with the water and the starch solution added, but NO potassium iodide. This bottle should then be held along side of the other in making the observation for color, and the light blue color will be more readily recognized.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 4

To be reproduced locally for distribution to Class Members

The Emergency Chlorination of Water

Many of the refinements of conventional chlorination need not be followed during emergencies. Supervision of chlorination is frequently more important than ascertaining what should be an adequate amount of chlorine, since continuous operation without interruption is imperative.

The amount of chlorine which reacts with organic matter in water is termed the *chlorine demand* of water. The chlorine demand, therefore, represents the difference between the dose of chlorine and the concentration of residual chlorine.

It is convenient to disinfect large water supplies through the use of liquid chlorine which contains no inert material, so that doses may be computed on the basis of liquid chlorine used.

Chloride of lime, known as bleach or calcium hypochlorite, will be extensively used for many purposes during the war and thus be difficult to obtain. Because chloride of lime deteriorates, it is best to assume that the material contains no more than 25% of chlorine by weight.

H.T.H. and Perchloron are compounds which are practically pure calcium hypochlorite. They contain 70% available chlorine by weight. Very little of these is available for chlorination of public water supplies, since the greater share of them is being allocated to the armed forces.

Simple tables and written directions are available as to the amount of material which must be used in the preparation of solutions for treating any specific supply.

Sodium hypochlorite solutions, known as liquid bleach, are economical to purchase and readily available at drug stores, grocery stores and janitor and milk supply houses. The strength of these solutions varies, but it is noted on the label of the container in each case.

For computation, the basic figure to remember for the use of 1% solution is that one gallon of the solution will provide a dose of 1.0 parts per million to 10,000 gallons of water, or that five

gallons of solution would treat 50,000 gallons of water with a dose of 1 p.p.m.

Household bleaches containing 1% to 5% of available chlorine are suitable for treatment of small volumes of water, but the 14% strength solution is used ordinarily in treating public water supplies. Care must be taken in computation that the volume of the stock solution is included as part of the volume of the final diluted solution. Add one part of 14% strength stock solution to 13 parts of water to give 14 parts of 1% solution.

In emergencies, when tables may not be available, there are a number of formulas which can be put to use. At such times a portable water-operated hypochlorinator may be used in conjunction with a fire engine pumper to pump treated water into a distribution system.

The orthotolidine test for residual chlorine is the best known test used in the control of chlorination of water. Its purpose is to indicate whether sufficient chlorine has been added to the water to react with organic matter and other chlorine consuming materials and yet have a surplus or residual which will remain in the water as active disinfectant for an appreciable period of time.

The principle of the orthotolidine test is based on the fact that orthotolidine reacts with chlorine to form a yellowish substance. The intensity of the color of this substance is proportional to the amount of residual chlorine reacting with the reagent.

For this test samples of water are removed from a water system. Special care must be exercised in the selection of the sampling point and in the collection of the samples. For primary purposes sampling should take place close to the point at which chlorine is being added.

Inasmuch as the disinfection of water requires an appreciable period of time, preferably 10 minutes before the water reaches the first consumer, the dose of chlorine should be sufficient to result in residual chlorine being present after a contact period of at least 10 minutes. Therefore, the sample of chlorinated water should stand in the sampling bottle until a reaction period of 10 minutes has elapsed before the concentration of residual chlorine is determined by orthotolidine test.

The regular chlorination of public water supplies frequently is controlled to a point equivalent to 0.2 p.p.m. of residual chlorine. Emergencies justify the use of 0.5 p.p.m. of residual chlorine as the minimum.

When the orthotolidine test is not available locally, in an emergency the starch iodide test may be used, the reagents being secured from a local druggist in accordance with available directions. The starch iodide reagent reacts with residual chlorine and produces a blue color, the intensity of which is roughly proportional to the concentration of residual chlorine.

CLASS LESSON NO. V

Disinfection of Water Mains, Tanks and Reservoirs

SYLLABUS FOR CLASS TRAINING SESSION NO. 5
2 Hours

Subject. Disinfection of water pipes, water handling equipment, tanks, reservoirs, etc.

Instructor. Instruction preferably should be given to a combined group of auxiliaries from all towns and villages in the county. An outstanding water works superintendent or a district engineer of the State Department of Health should serve as instructor.

Scope. *First hour:* Lecture on principles and methods of disinfecting pipes, utilizing both portable chlorination equipment and powdered hypochlorites, and the flushing and testing of water before service is resumed. Describe methods and dosages for disinfecting reservoirs and tanks, and related matters. Use prepared charts or blackboard sketches to illustrate particular features.

Second hour: Discussion period, oral quiz and demonstration of the batch disinfection of water in cans or tanks. Use bottles set up in laboratory with varying organic content. Demonstration should include calculations of amount of chlorine to be added and residual chlorine tests.

Assign for reading prior to lesson No. 6 some articles from recent water works literature relating to repair of water mains or tapping water pipes.

Reference Text for Lesson.

The disinfection of water works structures coming in direct contact with water which will be delivered to the consumers without subsequent treatment is intended to destroy bacteria introduced during emergencies and incidental to repairs to the structures and also to disinfect such structures following acts of sabotage when bacterial pollution may be wilfully introduced. The problem therefore is to secure rapid and certain disinfection without elaborate equipment being used and without the need for laboratory control of the disinfecting process. For this reason larger than usual

doses of disinfectants are advocated so as to insure effective results, even under unfavorable circumstances.

New water mains or water mains repaired following damage by bombing or other causes should be installed as promptly as possible to minimize interruptions in service and to prevent fire hazard incidental to lack of water. The great confusion which is likely to prevail following damage to water mains by bombing, however, may warrant the delay of repairs until the following day so that equipment and trained labor forces may be assembled for effective work. In any case, special attention must be given to repair procedures discussed in other lessons so that the disinfection of the repaired structure can be coordinated with these activities.

Preliminary Precautions. New or damaged structures should be cleaned as thoroughly as possible so that foreign matter, earth, sewage, etc. will not interfere with the subsequent disinfection of the structure. For the same reason final repairs to mains should be delayed when feasible until trenches or bomb craters can be dewatered to a point below the damaged main.

Disinfection of Water Mains. The disinfection of new or repaired mains is required by Regulation 6 of Chapter V of the State Sanitary Code. Such disinfection may be secured in one of three ways, namely, the use of portable chlorinators, the direct connection between a cylinder of liquid chlorine and a diffuser inserted in the main and finally the placing of dry chlorine compound powders in the mains as they are repaired.

Portable Chlorinators.

Portable chlorinators may be used to disinfect water mains in a manner identical to the emergency chlorination of potable water supplies discussed in lesson No. 4, except that higher doses of chlorine are used to insure the prompt disinfection of the main itself rather than the water flowing through the main.

Portable electric motor driven hypochlorite feeders are easily installed because only one connection need be made to the water main above the point of repairs. The manufacturers supply hard rubber pipe connections or special corporation cocks fitted with stuffing boxes, through which a silver diffuser may be inserted into the main and to which the chlorine solution hose is attached. The small electric motors driving these units are driven by 110 volt A. C. current.

The portable water driven hypochlorite feeders should be connected

to the main in the same way, but in this case water under pressure must be secured to operate the water piston or diaphragm which actuates the unit. Water under pressure should be secured by connecting a small rubber hose or pipe to a threaded faucet or hose connection on nearby property, or by a direct connection to a hydrant. The simplest procedure, however, would be to secure water directly from the repaired main through a second corporation cock installed for the purpose. This is feasible because the water-operated diaphragm is larger than the solution-pumping diaphragm. Water pressures exceeding about 8 to 10 pounds per square inch must be available to operate these units.

Liquid Chlorine Feeders. The portable units for feeding *liquid* (gaseous) chlorine may be of two types, namely, dry-feed chlorinators and solution-feed chlorinators. The former type would be connected through the use of a special silver tube to a chlorine diffuser, which is inserted in the water main through a special corporation cock. No water is needed for the operation of these units. It is impossible, however, to add more than 30 pounds of chlorine per 24 hours in this way, especially during the winter months, because "chlorine ice" is formed in the diffuser and stops the flow of gas.

Solution Type Feeders. Best results are secured therefore with the solution feed type of unit which is fitted with a water operated ejector, whereby chlorine water or strong chlorine solution is forced into the main. These ejectors, however, cannot be operated unless water is available at a pressure approximately three times the pressure of the water in the main being treated. For instance, water under a pressure of 240 pounds per square inch would be necessary to force chlorine solution through an ejector into the main under a pressure of 80 pounds per square inch. Ordinarily therefore a high pressure portable pump is needed to actuate the chlorine ejectors. These may be available in the larger municipalities. In a few instances portable chlorinators of this character are mounted on trailers and form a self-sufficient unit for emergency use.

Methods Without Use of Chlorinators.

Portable chlorinators may not be available, in which case two expedients are available.

First, chlorine gas may be introduced directly into water mains from chlorine cylinders, through the use of a silver tube between the cylinder and the diffuser inserted in the main through the special corporation cock noted above. The flow of gas from the cylinder

can be controlled only through the manipulation of the cylinder valve, which is not intended for this purpose, but this procedure is useful when large mains are being disinfected in the absence of portable chlorinators. Not more than about 30 pounds of gas can be evaporated from a 100 to 150 pound chlorine cylinder per 24 hours, so larger volumes must be secured through the use of more than one cylinder.

Secondly, hypochlorite solutions may be introduced through the use of small hand operated force pumps, such as the "hydraulic pressure or test pump" widely used to test the tightness of new mains. Best results are secured when the solution is forced through a corporation cock into water flowing through the repaired main to a hydrant, which is opened to waste to provide the desired estimated rate of flow of water. Complete directions are as follows:

1 When the repair work is finished, turn the water on and flush thoroughly through a hydrant or through a blowoff connection provided especially for this purpose. If possible, let the water run long enough to remove all indications of dirt and foreign material.

2 Apply chlorine solution by means of a hand pump, the procedure for which is as follows:

A Make up chlorine solution according to table No. 1, below.

B Connect pump to main. For this purpose use either a corporation cock or have an adaptor which can be connected to a hydrant at the inlet end of the line. In any case, the chlorine solution must be applied at or just ahead of the inlet end of the section which is being treated.

C Open hydrant or blowoff at the outlet end and adjust the flow approximately to one of the rates indicated in table No. 2, below.

D When the flow is adjusted to the required rate, signal the attendant at the inlet end to start pumping the solution into the line. Operate the pump so as to deliver one gallon of solution in three minutes.

E Continue pumping until an orthotolidine test on a sample taken from the discharge end of the line being treated shows a dark orange or red color. If the contents of the can are used before the test shows the proper color, signal the attendant at the discharge end to close the hydrant or blowoff. Be sure to do this before the can is empty, so as to avoid any possibility of interrupting uniform treat-

ment. Then refill the can with chlorine solution and signal the attendant at the discharge end as soon as pumping is resumed.

F After finishing the application of chlorine, disconnect the pump and flush the pump thoroughly with fresh water. This is needed in order to prevent damage which would otherwise result if the chlorine solution were allowed to remain in contact with the metal parts of the pump.

3 Isolate the line by closing valves and allow heavily chlorinated water to stand therein for the longest possible period. Experience indicates that such contact periods should range anywhere from four to twenty-four hours, although it might not be possible to allow this much time in an emergency.

The suggested rates for water flow and chlorine pumping apply to mains of all ordinary sizes and are based on a chlorine dose which will assure complete destruction of harmful bacteria. If the available water flow is lower than called for by the table, it will not be necessary to make a corresponding reduction in the pumping rate. The amount of excess chlorine thus applied is insignificant on a cost basis and certainly not worth saving in any situation calling for emergency chlorination.

TABLE NO. 1

Chlorine Solution Strength, Hand Pump Method of Main Chlorination

Discharge Rate GPM	*Amount of Chemical in 5 Gallons of Solution*		
	Grocery Store Clorox	*14% Strength Sodium Hypochlorite*	*HTH or Perchloron*
10	0.5 gallon	1.0 pint	0.25 pound
20	1.0 gallon	1.0 quart	0.50 pound
35	1.5 gallons	3.0 pints	0.75 pound
50	2.0 gallons	2.0 quarts	1.00 pound
75	3.0 gallons	3.0 quarts	1.50 pounds
100	4.0 gallons	1.0 gallon	2.00 pounds

The hand pump method is simple and effective. However, if the indicated procedure has to be varied because of unforeseen conditions, it is only necessary to regulate the pump rate and to control the water flow in such a way that a sample of the treated water will show a dark orange or a red color when tested with orthotolidine. In such cases it is possible also to increase the strength of the chlorine solution.

1 Add enough water to indicated amount of chemical to make a total of five gallons of solution. For example, for a 50 gallon per minute discharge rate and using 14% strength sodium hypochlorite, make up the chlorine solution by adding two quarts of the hypochlorite to four and one half gallons of water.

2 Operate the hand pump at the same rate in all cases. This rate is five gallons in fifteen minutes, or one gallon in three minutes.

3 Discharge rate depends on size of job and will seldom exceed 50 gallons per minute. Rates up to 50 GPM can be regulated with sufficient accuracy by checking the time it takes to fill a five gallon can. Higher rates require a larger container, possibly a 25 or 50 gallon drum. With a little experience any of above rates can be approximated merely by observation.

4 Quantities given in the table represent minimum requirements. Stronger solutions can be used if so desired. In any event, doses are approximate only and there is absolutely no need to spend time in figuring the exact amount of chemical and of solution required for any given job.

TABLE NO. 2

Time Required to Treat 100 Feet of Pipe, Hand Pump Method of Main Chlorination

Discharge Rate GPM	*Time in Minutes to Treat 100 Feet of Pipe*					
	2 in.	*4 in.*	*6 in.*	*8 in.*	*10 in.*	*12 in.*
10	2	7	15	26	41	59
20	..	3	7	13	20	29
35	..	2	4	8	12	17
50	..	..	3	5	8	12
75	..	..	2	4	6	8
100	..	..	..	3	4	6

The approximate time required for any job can be readily computed from the above table. In conjunction with table No. 1, it can be used also for determining what strength solution to apply and the approximate quantity of that solution needed for any given length of main. For example, 600 feet of 8 inch main, using a discharge rate of 50 GPM, and 14% strength sodium hypochlorite, would be fully treated in 30 minutes and the total solution pumped in would be 10 gallons. This amount of solution, as seen from table No. 1, would require two charges of two quarts each, or one gallon in all.

Forcing Chlorine Solution Through Fire Hydrants.

There may be occasions when a distribution system is polluted through a cross connection or through acts of sabotage and when disinfection may be necessary without the main being exposed. Under these circumstances the chlorine solution may be forced through fire hydrants into the portion of the distribution system involved.

The distribution system of the city of Rochester was disinfected during an emergency in this manner through the use of improvised equipment. Motor driven street flushers of 2500 gallon capacity were used as solution tanks, the small force pump on the unit being used to circulate and mix the strong hypochlorite solution prepared by adding 5 pounds of H.T.H. to water filling the tank to a depth of about 1 foot. The tank then was filled with water from the hydrant. The 2500 gallons of solution so prepared having a strength of 165 p.p.m. available chlorine was forced into about 50 selected fire hydrants through the use of fire engines, the suction hose of which was led to the sprinkler tanks and the discharge hose of which was connected to the fire hydrant. Another hydrant about 400 feet from the point of application was opened to produce a flow of about 250 g.p.m. which gave a dose of about 5 p.p.m. in the flowing water. When the water flowing from the hydrant contained residual chlorine the hydrant valve was closed and another one opened further from the point of treatment. This was repeated with other hydrants and points of treatment. Special precautions were taken with hydrants on dead-ended mains. In this way large volumes of disinfecting solution were forced into various portions of the distribution system so as to secure effective disinfection of the system throughout a large area.

Doses of Chlorine. The volume of water in the mains disinfected in this manner through use of portable chlorinators usually is not known, but when known the chlorinators should be adjusted so as

to provide doses of approximately 50 p.p.m. If the dose cannot be computed, the simplest procedure is to add a heavy dose of chlorine based upon the estimated amount of water in the main subject to repairs. The heavily chlorinated water would be allowed to flow through the repair mains to a nearby fire hydrant located below the repaired section until the waste water leaving the hydrant contains sufficient residual chlorine to produce a dark red color when the orthotolidine reagent is added or a blue-black color when the starch iodide reagents are added. When there is definite assurance that the heavily chlorinated water has reached this hydrant, the hydrant valve should be closed and the water allowed to stand in the mains for at least 30 minutes and preferably longer.

In the meantime the heavily chlorinated water should be allowed to flow through house connections directly from the repaired portion of the mains so that these connections in turn may be disinfected. This is very essential inasmuch as these connections may be subject to pollution through back siphonage, which is more likely to occur when the water pressure is reduced during the repairs. Finally the heavily chlorinated water is flushed to waste through the fire hydrant and normal service is restored.

Summary of Directions for Auxiliaries and Volunteers.

Following are summarized directions which should be given auxiliaries and volunteers assisting in the disinfection of water mains.

Liquid Chlorine.

1. Install a corporation cock on the original pipe line near point of connection with new mains.
2. Install a special diffuser through a special stuffing box on this corporation cock and connect cylinder of chlorine or the portable dry-feed chlorinator with this silver tube by flexible cooper or silver tubing, or install special silver tube and rubber hose from solution-feed chlorinator.
3. Flush out the new pipe line to be disinfected.
4. Open up the end-most valve or hydrant on the new main several turns to permit water to flow at a slow rate. The gate valve on the supply main then should be opened part way to admit water under reduced pressures into the new pipe line during treatment. The water pressure must be kept below thirty pounds, otherwise chlorine gas will not flow readily from the tank.

5 Open the valve on the chlorine cylinder or chlorinator and allow chlorine to enter the water flowing through the new mains.
6 Collect a sample of water from the end-most hydrant or valve and continue treatment until the water contains sufficient residual chlorine to develop a strong red color when orthotolidine reagent is added to a sample of the water.
7 Stop the flow of water and chlorine gas by closing appropriate valves and withdraw silver tubing and close corporation cock.
8 Allow the water so treated to stand in the mains for at least 30 minutes and preferably for twelve hours, following which period the mains should be thoroughly flushed until the water runs clear and has no odor of chlorine.

The same procedure is followed with portable hypochlorite solution feeders.

Disinfecting a New Main Section. If water is to be supplied to consumers through a section of new mains before construction work on the whole system is completed, it is possible to disinfect each portion as laid by installing a special plug fitted with a rubber gasket that can be clamped in the bell, or, if necessary, on the spigot end of the pipe. This plug should be fitted with a short nipple and stop cock whereby the air in the main may be released as the water is turned on and through which a sample of water can be collected for making the orthotolidine test.

Disinfecting Repaired Mains with Hypochlorite Powders. In the absence of portable chlorinators, small quantities of chlorine compounds should be placed in the empty mains when they are being repaired. Water introduced into the repaired mains, however, may flush the powder to the end of the repaired section before the disinfectant has dissolved and has had time to act, so this procedure should not be followed except when portable chlorinators are not available. Emergencies may arise, however, which may necessitate the use of this procedure, so main repair squads should be given detailed and explicit instructions as to the use of chloride of lime, H.T.H. or Perchloron for this purpose. Table No. 1 below gives the quantity of chloride of lime, H.T.H. or Perchloron required for mains of various sizes and for the specified length of the main. The second table gives the capacity of each 20 foot length of various sizes of mains and the corresponding weights of chloride of lime, H.T.H.

or Perchloron needed to produce a dose of 50 parts per million available chlorine.

The procedure to be followed in the use of chlorine compounds for this purpose may be summarized as follows:

Calcium Hypochlorite Compounds.

1 Place the required quantity of chloride of lime (calcium hypochlorite), "High Test Hypochlorite" (H.T.H.) or "Perchloron" shown in the following table as the pipe is laid.

TABLE 1

Quantity of Disinfectant Required to Provide Dose of About 50 P. P. M.

Diameter of Pipe	*No. of Lengths of Pipe per Application*	*Ounces of Chloride of Lime per Dose (25% Available Chlorine)*	*Ounces of H.T.H. on Perchloron per Dose (65% Available Chlorine)*
4	4	1.0	0.5
6	4	2.5	1.0
8	3	3.0	1.5
10	4	7.0	2.5
12	3	7.5	3.0
16*	2	9.0	3.5
18	3	12.5	5.0
20	2	10.5	4.0
24	2	15.0	6.0
30	2	23.5	9.0

* Pipes less than 16 inches in diameter have lengths of 16 feet. Larger pipes have lengths of 12 feet.

2 Open the end-most valve and furthermost hydrant on the new pipe line, and open the gate valve on the water main to which the new pipe is attached a few turns to admit water at a slow rate to fill the new piping with water. Then close the hydrant and end-most valve on the line and allow the chlorinated water to stand in the pipe for twelve hours.

3 Then open up successively all the hydrants on the line, beginning with that nearest the supply end of the pipe, and flush the main until the water runs clear and is free from chlorine odor.

In case of dead-end pipe lines, instruct occupants of houses connected to the pipe to open up service taps until the chlorine odor disappears from the water.

TABLE 2

Pipe Size Inside Diameter in Inches	*Volume Capacity of 20 Foot Length*			*H.T.H. required per 20 foot length to give treatment 50 p.p.m. available chlorine-ounces*
	Cu. ft.	*Lbs. water*	*Gallons*	
4	1.75	109	13.1	1/8
6	3.93	245	29.4	1/4
8	6.98	436	52.2	1/2
10	10.91	681	81.6	3/4
12	15.71	981	117.5	1 1/8
16	27.92	1,745	208.8	2
20	43.64	2,727	326.4	3 1/8
24	62.84	3,927	470.0	4 1/2
30	98.18	6,136	734.4	7
36	141.38	8,836	1,057.6	10 1/8
42	192.42	12,026	1,439.4	13 3/4
48	251.32	15,707	1,880.0	18

Emergency Chlorination of Tanks, Standpipes and Reservoirs.

Steel elevated tanks, standpipes and concrete reservoirs used for the storage of water which will be delivered to the public without subsequent disinfection should be thoroughly cleaned and disinfected following construction, repairs, or when pollution is suspected through acts of sabotage. The cleaning process is intended to remove organic matter and foreign material which may prevent the chlorine from reaching the surface of the structure and also to reduce the absorption of chlorine.

Three methods of disinfection of such structures are available: namely, the direct application of a strong disinfecting solution to the inner surfaces of the empty structures; secondly, the heavy chlorination of entering water used to fill the structure; and thirdly, direct application of the disinfectant to water present in the filled structure. The first procedure is more economical of chlorine solution but involves

considerable labor. The second procedure is the simplest. In any case the details of the following procedures should be explained to volunteers and auxiliaries so that they will have simple but specific instructions to follow.

First Procedure. *Disinfecting the Surfaces of Empty Structures.* The disinfecting of surfaces of tanks and reservoirs requires the use of a solution of approximately 200 parts per million available chlorine to insure rapid and effective results. This strength solution may be prepared by one of several procedures. First, one ounce of chloride of lime would be thoroughly mixed and dissolved in each ten gallons of solution. Secondly, one ounce of H.T.H. or Perchloron would be dissolved in each 26 gallons of solution. Thirdly, one gill or ⅛ quart of liquid bleach of 5% strength would be mixed with eight gallons of water.

The powders should be made into a paste with a small amount of water and the paste diluted with the stated volume of water. The resulting solutions should be sprayed over the inner surfaces of the empty structures through the use of fruit tree spraying equipment or should be applied through the use of a wide brush such as a whitewash brush. Do not fill the structure with water until the disinfectant has had at least 30 minutes to act.

Second Procedure. *Use of Portable Chlorinator.* Install a portable or homemade chlorinator on the pipe line leading to the tank or reservoir and adjust the equipment to provide a dose of approximately 50 parts per million to the water used to fill the structure. This dose requires the use of 1½ pounds of chloride of lime or ½ pound of H.T.H. or Perchloron for each one thousand gallons of water used to fill the structure. For instance, 75 pounds of chloride of lime would be needed to disinfect 50,000 gallons of water ($1\frac{1}{2} \times 50 = 75$) needed to fill a tank of that capacity.

Third Procedure. *Batch Treatment.* The third procedure involves the use of the same doses of disinfectant as noted for the second procedure, but where in the absence of a portable chlorinator the disinfectant must be added by hand in batches as the structure is filled. If the filling process is reasonably uniform, it should be possible to develop a schedule based upon the number of thousands of gallons of water entering the structure in any given period of time, such as one half hour. For instance, if the structure is being filled at the rate of 5,000 gallons per hour then 7½ pounds ($5 \times 1\frac{1}{2} = 7\frac{1}{2}$) chloride of lime would be mixed with a small volume of water and

the resulting solution would be poured every hour into the structure near the intake pipe in such a manner as to distribute the material as effectively as possible. If the entering water does not produce some agitation, a portion of the solution should be added to various sections of the structure so as to secure as effective distribution as possible.

The Disinfection of Water Handling Equipment and the Chlorination of Small Volumes of Water.

Citizens have been advised by local War Councils to avoid filling bath tubs and other vessels with water *during air raids* because this would seriously overtax the capacity of public water supply systems and interfere with fire protection. Citizens have been encouraged, however, to store a limited volume of potable water for emergency use. Gallon bottles are convenient for this purpose.

Complete water failure may occur in a municipality during an extreme emergency, so that one should plan in advance for the delivery of drinking water through the use of tank trucks and other portable containers. Plans for this work should be in cooperation with local War Councils and local health departments.

Equipment. Milk cans and milk tank trucks are carefully maintained and are specially adapted to the transportation of potable water. It is likely, however, that these will be needed for the transportation of emergency milk supplies, so reliance should be placed upon the use of any available water tank, wagons, street sprinkling equipment, water barrels placed on trucks, etc. Gasoline tank trucks could be used if necessary following appropriate cleaning.

Cleaning Tanks and Portable Containers. Milk cans and milk tank trucks are maintained clean so that no special precautions are needed prior to their use for transporting water. Such equipment when used for transporting water should be thoroughly disinfected before subsequent use in transporting milk. Water tank trucks, street sprinklers, etc., ordinarily are used for transporting non-potable water, so that special precaution should be taken to cleanse and disinfect such equipment.

In many instances flushing alone will suffice prior to disinfection. If, however, cleansing is necessary, the simplest procedure is to make a strong soap solution with the contents of a box of soap flakes or about 1 quart of soft soap and to thoroughly distribute strong soap solutions over the inner surface of the equipment. The soap is then thoroughly flushed from the equipment prior to disinfection.

Gasoline tank trucks are not suitable unless special precautions are taken to remove the traces of gasoline and the tetraethyl lead present in most gasolines. The best procedure is to thoroughly steam the tank so as to evaporate the gasoline, following which the tank should be thoroughly washed with a strong soap solution and then rinsed with water.

Disinfection of Equipment. Clean equipment should be disinfected either with live steam or by chlorination. The following directions provide a dose of chlorine of 50 p.p.m. which should be sufficient to insure effective disinfection without the need of laboratory control. The portable containers may be disinfected by one of the three procedures given above for tanks, standpipes and reservoirs. Smaller vessels such as milk cans and barrels may be disinfected by using a strong solution prepared by adding 1 oz. of chloride of lime or ½ ounce of H.T.H. or Perchloron to 10 gallons of water. An alternate is to add 1 gill or ⅛ quart of 5% strength liquid bleach to 8 gallons of water. This strong solution is applied to the inner surface of the cans or barrels. Possibly the simplest method of disinfecting milk cans is to prepare 50 gallons of strong chlorine solution in a barrel of water by mixing 5 ounces of chloride of lime or 2 ounces of H.T.H. or Perchloron in a barrel of water. The cans are then immersed in this solution.

Disinfecting Small Volumes of Water. The water being transported in properly disinfected containers may be of known safe potable quality. However, if water is of unknown or questionable quality, it should be disinfected with a dose of at least 2.0 p.p.m. chlorine. This dose may be secured by mixing 1 oz. of chloride of lime into a paste and by adding the paste to 1,000 gallons of potable water or by adding 1 oz. of H.T.H. or Perchloron to 2800 gallons of water, or by adding 1 gill of 5% strength liquid bleach to 800 gallons. The disinfectant should be mixed thoroughly in the water being treated. In cases of doubt, add larger doses of the disinfectant until the taste of chlorine is noted in the treated water, unless the treatment is subject to control through the use of orthotolidine test and treated water contains 0.5 p.p.m. residual chlorine after a reaction period of at least 15 minutes.

Smaller volumes of water may be chlorinated by adding 1 to 1½ teaspoonfuls of 5% liquid bleach to 50 gallons of water.

Small volumes of water placed in milk cans, etc., may be disinfected as shown by the following tabulation.

Size of Milk Can —Quarts—	Number of Drops of 5% Liquid Bleach or Sodium Hypochlorite
8	4
20	10
40	20

This is equivalent to 2 drops per gallon of water treated, or about 1½ teaspoonfuls per barrel of 50 gallons of water.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 5

To be reproduced locally for distribution to Class Members

Disinfection of Water Mains, Tanks and Reservoirs

The problem in chlorinating water works structures during emergencies is to secure rapid and certain disinfection without using elaborate equipment and laboratory control of the disinfecting process. For this reason, disinfectants in doses larger than usual are advocated in order to insure effective results under unfavorable circumstances.

Disinfection of new or repaired mains may be secured in any one of the following ways:

1 With portable chlorinators.
2 With cylinders of liquid chlorine having a diffuser inserted in the main.
3 With the placing of dry chlorine compound powders in mains as they are repaired.

Much high doses of chlorine are used, namely, at least 50.0 p.p.m., to disinfect the mains themselves, than in the case of the water flowing through them.

When using portable water-driven hypochlorite feeders, it is necessary to secure water under pressure for the operation of the actuating piston. This pressure can be secured by means of a hose or pipe connection to a faucet or hydrant, or a second corporation cock installed for such purpose.

Portable units for feeding liquid (gaseous) chlorine may be of two types: dry-feed chlorinators and solution-feed chlorinators. Best results are secured with the solution-feed type of unit, fitted with a water operated ejector which forces chlorine solution or water into the main. These ejectors will not operate unless the water pressure available is at least three times that in the water main.

When the portable chlorinators are unavailable, the following expedient may be resorted to: the disinfectant may be introduced directly into water mains from chlorine cylinders; the flow of gas can be controlled only through the manipulation of the cylinder valve.

However, the pressure in the cylinder must at all times be well in excess of the pressure in the main and chlorine withdrawal limited to not more than 30 lbs. from one cylinder per day.

Sometimes disinfection is necessary even though mains are not exposed. Chlorine solution may then be forced through fire hydrants and into the portions of the distribution system involved.

The volume of water in the mains which are to be disinfected is oftentimes not known. When it is known, the chlorinators should be adjusted to provide doses approximating 50 p.p.m. If the dose cannot be computed, the simplest procedure is to add a quantity based upon the estimated amount of water in the main subject to repairs. The disinfectant should be given at least 30 minutes to do its work, and preferably longer.

Heavily chlorinated water should be allowed to flow through house connections leading directly from repaired portions of mains, so that these connections may in turn be disinfected.

If water is to be supplied to consumers through a section of new mains before construction work on the whole system is completed, it is possible to disinfect each portion as it is laid.

When portable chlorinators are unavailable, small quantities of chlorine compounds should be placed in the empty mains being repaired. *Detailed instructions are available to repair crews so that they may know the proper procedure in the event of an emergency.*

Elevated tanks of steel, standpipes, and concrete reservoirs that are used for the storage of water which is to be delivered to the public without subsequent disinfection should be thoroughly cleaned and disinfected following construction, repairs or when pollution is suspected. Three methods of disinfection of such structures are available:

1. Application of strong disinfecting solution to inner surfaces.
2. Heavy chlorination of incoming water used to fill the structure.
3. Direct application of disinfectant to the water already present in the structure.

The disinfecting of surfaces of tanks and reservoirs (Method 1) requires the use of a solution approximating 200 p.p.m. of available chlorine to insure rapid and effective results. One ounce of chloride of lime, thoroughly mixed and dissolved in each ten gallons of solution, will produce 200 p.p.m. of available chlorine.

A dose of 50 p.p.m. available chlorine would be used with methods 2 and 3.

The Disinfection of Small Volumes of Potable Water.

Citizens have been advised to store only a limited volume of potable water for emergency use and to draw no water during an air raid. Gallon bottles or jugs are convenient. In the event of complete water failure, provision should be made for the delivery of water by means of tank trucks. Other equipment may, of course, be used: Milk cans and milk tank trucks, water tanks, wagons, street sprinkling equipment, water barrels carried on trucks, etc.

Prior to the disinfection of any of this equipment, cleaning may be necessary. Thorough cleansing with strong soap solution is very effective.

Clean equipment should be disinfected either with live steam or by chlorination. Possibly the simplest method of disinfecting milk cans and containers of like proportions is to immerse them in a 50 gallon barrel of chlorine solution having a strength of 50 p.p.m. of available chlorine. This strength can be obtained by mixing 5 ounces of chloride of lime or 2 ounces of H.T.H. or Perchloron to a barrel of water.

Whenever there is doubt as to the potability of water, larger doses should be added to it until the taste of chlorine is noted.

Smaller volumes of water may be chlorinated by adding 1 to 1½ teaspoonfuls of 5% liquid bleach to 50 gallons of water. Small volumes contained in milk cans, bottles, etc., may be disinfected as shown by the following tabulation:

Size of Milk Can —Quarts—	*Number of Drops of 5% Liquid Bleach or Sodium Hypochlorite*
8	4
20	10
40	20

This is equivalent to 2 drops per gallon of water treated, or about 1½ teaspoonfuls per barrel of 50 gallons capacity.

CLASS LESSON NO. VI
General Repair Technics

SYLLABUS FOR CLASS TRAINING SESSION NO. 6

2 Hours

Subject. General repair technics.

Instructor. Instruction preferably should be given to a combined group of auxiliaries from all towns and villages in the county. Some employee of a water department who is expert in making repairs, taps, joints, laying pipe, etc., should serve as instructor.

Scope. *First hour:* Lecture on different types of equipment used in repair work, leak detector, hoists, tapping machines, wet cut or other cutting machines, solid sleeves, split sleeves, flexible couplings, methods of tapping, jointing, installation of corporation cocks, methods of sheeting, and related matters.

Second hour: Demonstration of methods using actual equipment set up in shop or some suitable location.

Assign for reading prior to lesson No. 7 some article from current technical literature relating to emergency repairs of broken water lines.

Reference Text for Lesson.

The Distribution System. A waterworks distribution system consists of a network of pipes, valves, hydrants, service connections, distribution tanks and reservoirs and all other appurtenances provided for the conveyance of water between the pumping station or storage reservoir and the ultimate consumer. Probably no two systems are exactly alike but they consist generally of large arterial feeders or trunk mains that transport the water at low velocities to the smaller distributor pipes. The size of the piping should be such that water in sufficient quantities at adequate pressures can be furnished to meet the normal domestic, industrial and public demands at all points of the system. A most important public use of a water supply is the extinguishing of fires and it is found that the capacity of the distribution system is frequently controlled by the fire protection demands.

Maps and Records. Too much emphasis cannot be placed on the importance of maps and records in the efficient operation and main-

tenance of a distribution system. They should be clear, accurate and complete in showing the location of all mains, valves, hydrants and the other component parts of the system. Due to the haphazard manner in which many early records were entered and preserved it is generally conceded, by waterworks operators, that they are extremely doubtful of the accuracy of some recorded main locations. They will also admit that it requires something approaching constant vigilance to prevent the concealment of valve and service boxes.

Tools and Equipment.

The Pipe Locator. When necessary, for any of many reasons, to check the location of a water main it may be done by the use of an electric pipe locator. The action of one type of this device is based on the fact that a magnetic field is created about a conductor carrying an electric current and that the voltage of a few dry cells may be stepped up to probably 150 volts and made intermittent by an induction coil called a vibrator. By attaching this vibrator to any part of the pipe to be located or to any exposed connector to that pipe, such as a hydrant, a high voltage, low amperage, pulsating current may be sent through the pipe. This current causes a magnetic field about the pipe and induces a current in a coil of wires, called a loop, when it is in the vicinity of the magnetic field. The effect of the current in this loop may be amplified, measured and observed by radio tubes, earphones and meters. It is a simple matter with this equipment to locate the center of the magnetic field, which in turn accurately locates the pipe. In another type, a small radio transmitter sends out impulses that are detected and amplified by a receiver. When the receiver and transmitter are in line and directly above the pipe to be located, the receiver meter readings will be a maximum. The great advantage of the latter type is that for successful operation it is unnecessary to make electrical connections to the pipe or to any of its attachments.

Dipping Needle. A dipping needle is used to locate covered valve and curb boxes. It is simply a compass or a magnetic needle supported on a horizontal axle so that it can rotate vertically. Fortunately for those of us who have occasion to look for covered valve boxes, when an iron body is placed in or driven into the earth, vertically, it will always have a south or negative pole at its upper end. It is this magnetic action of the earth that is used to advantage in locating covered valve boxes. However, the magnetic field is weak and cannot be readily detected when the cover consists of more than a foot or so of earth or other material.

The Pipe Material. Reduced to its most common constituent, a distribution system is composed of a great many lengths of pipe connected by a great many joints. A large variety of materials have been successfully manufactured into water pipe, including wood, iron, steel, concrete and asbestos. They all have their outstanding characteristics and recognized advantages that depend on the particular requirements and circumstances for which they are to be used.

Cast Iron. The pipes of the earliest systems both in this country and in Europe were made of wooden logs bored to a diameter of about six inches. In 1664, cast iron water pipes were first laid in France and after more than 250 years are still in service. The quality of the water and the surrounding soil are undoubtedly great factors in contributing to the longevity of these pipes. Today, cast iron pipe predominates as the pipe material in a distribution system. It has a history of proven durability and it meets the requirements of moderate cost and strength. It may be conveniently cast into any desired form and consequently it is well suited for pipes that require many branches or special fittings. Cast iron pipe is pitcast in four classes designated as A, B, C, and D, designed for working pressures of 43, 86, 130 and 173 lbs. per sq. in. respectively, or centrifugally spun for various working pressures, viz., class 150, 200, etc.

The Bell and Spigot Joint. The bell and spigot joint is the principal method of connecting buried cast iron pipe. Because of its tightness when well laid, strength and flexibility, it is almost universally used. Its flexibility permits moderate expansion and contraction due to variations in temperature and allows some settling of the supporting soil. In forming the joint, braided hemp, or some other yarning material, is first wrapped around the spigot end before it is placed in the bell. The purpose of the bead on the spigot end of the pipe is to hold the jointing material firmly in place. It also aids in centering the pipe, so that a joint of uniform thickness may be obtained. The spigot end is slipped into the bell until it makes perfect contact with the hub of the bell. Additional hemp is then inserted into the joint and thoroughly packed with a yarning tool. Sufficient yarn must be used so that it fills the joint up to within 2½ to 3 inches of the face of the bell. A jointer is wrapped around the pipe tightly and held against the face of the bell to guide the lead into the joint. After cooling, the jointer is removed and the lead is finally set up by a calking iron. The contraction of the lead due to cooling causes the joint to open slightly and calking is required to complete the joint. Formerly most of the calking was done by hand; however, if com-

pressed air is available, pneumatic calking tools will reduce the time of calking and produce a better joint.

Jointing Compounds. For many years lead had been used exclusively for casting bell and spigot joints but many satisfactory substitutes called jointing compounds are now available. Their principal constituent is sulphur in combination with inert materials such as slag, iron and salt. The joints are formed in a similar manner to lead joints with the exception that the compound requires less heat to melt and because it does not shrink as it cools, it does not require calking. Frequently joints formed with these compounds are not tight when first poured but due to the self-sealing properties of the material the leakage gradually subsides and in a short time a tight joint is produced.

Lead Wool. Cold lead in the form of lead wool has been employed to some extent in forming bell and spigot joints. Its use may be indicated on emergency repairs to old joints in wet trenches when it is not possible or practical to pour a joint.

Cement. In some localities the results obtained with ordinary Portland cement as a jointing material in a bell and spigot joint have been satisfactory. In making the joint the slightly moistened cement is rammed into the bell with a tool similar to a yarning iron.

Flanged Joint. The flanged joint was used on the earliest types of cast iron pipe, but because of its rigidity it has been largely superseded by the bell and spigot joint for underground pipes. Its principal use is above ground and it has the advantage that when necessary a length of pipe may be unbolted and readily removed from a line of pipe. The joint is simply made by placing packing between the flanges and drawing them together with bolts.

The Universal Joint. The universal joint is a type of bolted joint that has been developed to permit some degree of flexibility without causing leakage. The pipe is made in standard six-foot lengths having lugs at each end that are cast as an integral part of the pipe. For moderate pressures the joints are provided with two iron bolts, but the high pressure pipe has four bolts at each joint. It forms a machined, iron-to-iron joint that does not require the pouring of a molten material nor special skill or workmanship to complete it.

Mechanical Joint. Several types of mechanical joints are available for connecting plain end pipe of all materials and diameters. In general

they consist of flanged rings which, being bolted together, compress a rubber gasket against the pipe and form a simple tight and flexible joint. Their peculiar advantages may be readily applied to emergency repair work. They can be assembled and dismantled quickly with a wrench as the only tool by unskilled labor under the most unfavorable weather and trench conditions. They are adjustable to ordinary variations in bell and spigot dimensions.

Fittings. One of the important advantages of cast iron pipe is that special castings called fittings are usually available. They are connected to the pipe by the bell and spigot or the flanged joint and appear in the following forms: bends of various radii used when it is necessary or desirable to change the alignment or the grade of the pipe; offset to avoid an interfering obstruction; reducers to vary its size; tees, to make branch connections and crosses when the pipe is to be connected to an intersecting main.

Plugs and Caps. Plugs are inserted into the bell end and caps over the spigot end of the pipe when temporarily closing off sections of pipe during repairs or for permanently capping dead ends. In England rubber expansion stoppers said to give a tight joint have been used on temporary repairs to avoid the time lost in installing regular caps and plugs.

Steel Pipe. Steel pipe is stronger than cast iron pipe of the same wall thickness. Consequently a lighter pipe can be used to withstand the same pressure. It has the advantage because of its weight, of being fabricated in longer lengths, it has fewer joints and it is easier to handle and transport. It is especially adapted to long transmission lines and large trunk mains with only occasional side connections. The circumferential joints are usually riveted, welded, flanged, coupled or connected by some type of patented joint. To prevent corrosion, steel pipe is covered with a prepared coating. On account of the comparative thinness of the metal it is very important that this coating should be well applied and protected from injury, as the durability of the pipe may eventually depend on it.

Asbestos-Cement Pipe. Asbestos-cement pipe was developed in Italy about twenty years ago and has been used in this country for about half that time. It is composed of 15% asbestos and 85% Portland cement. It has the following advantages: lightweight; easily handled; requires no calking; resists corrosion; cutting is performed with an ordinary wood saw. The joint utilizes two round rubber

rings in combination with a flexible sleeve type coupling of the same material as the pipe. The fittings are usually of cast iron. Perhaps water works operators are to become better acquainted with the non-metallic pipe materials, particularly during war time.

Service Pipes. Lead, galvanized iron and copper are the materials commonly used in the service pipe which is the small lateral connection between the main and the property to be supplied. These pipes are connected to the main by means of a special valve called a corporation cock. In the older installations these cocks had a smooth tapered end and were driven into a drilled hole in the pipe. In more recent years the cocks are provided with threaded tapered ends and are screwed into the pipe usually by a tapping machine. In some installations a flexible gooseneck connects the corporation cock to the service pipe, which permits of some adjustment due to any uneven settlement of either the main or the service pipe.

The Corporation Tapping Machine. The corporation tapping machine makes taps and inserts cocks ½ inch to 2 inches in diameter in mains under pressure. The machine consists essentially of two chambers, upper and lower, separated by a watertight gate. The machine is first securely chained to the pipe and the combination drilling and tapping tool is lowered through the gate to the surface of the pipe. After a hole has been drilled and tapped in the pipe, the tapping tool is drawn up into the upper compartment, the gate between the compartments is closed, the pressure released and the tool removed from the machine. The tapping tool is then replaced by a corporation cock in an off position and the same procedure is repeated to screw the corporation cock into the main.

Tapping Machine. Lateral or branch connections larger than 2-inch to existing mains are made by cutting out a section of the pipe and sleeving in a tee or by using a tapping or drilling machine which permits the connection to be made under pressure. In using the machine a special tapping split sleeve with a bell and spigot or flanged side outlet for the branch is first bolted on the pipe and calked into place. A special tapping valve is then permanently connected to the sleeve and the machine is temporarily bolted to the valve. The valve is fully opened, the cutter is forced through the valve and against the main and the cut is made. The cutter and the piece of the pipe are withdrawn back of the valve which is then closed. The machine is removed from the valve and the connection is completed.

Solid Sleeves. One of the most useful and inexpensive of all repair items is the sleeve, both in the solid and split types. The solid sleeve is essentially a single piece of pipe from 10 to 24 inches long, depending on its diameter, and having two bell ends. Before it can be installed on an existing main for repair purposes it is first necessary to cut and remove a section of the pipe. The sleeve is slipped over the pipe and calked into place in the usual manner. Its principal use is for sleeving in sections of new pipe, to replace defective or broken pipe and to install branch and hydrant connections on existing mains.

The Split Sleeve. Split sleeves are similar to solid sleeves, with the all important exception that the body of the sleeve is made in two sections which are to be bolted together about the pipe. They vary in length from 10 to 24 inches, also depending on its diameter. They are used for enclosing circumferential splits and breaks or short horizontal cracks. They eliminate the necessity of cutting out defective sections of the pipe and installing a solid sleeve.

The split sleeve is also produced with mechanical end joints that will enclose about 8 inches of a defective section. In this type a follower is bolted to the sleeve body compressing a gasket and forming the joint. They may be had with interlocking ends to enclose a longer section of pipe and in a special type for the repair of split bells and breaks in the pipe close to the bell.

Couplings. Couplings are variations of the split and solid sleeves with mechanical end joints. One type consists of a flared end middle ring, two wedge section rubber compound gaskets, two follower rings and the necessary bolts. Another split coupling type consists of two split rings, one triangular shaped gasket, a metal band and bolts. They are used for repairing split and broken pipe, for joining plain end pipes and for inserting valves and branches. They eliminate the pouring and calking of joints, accelerate repairs and may be assembled under adverse conditions even under water, if necessary. Their numerous repair applications are only limited by the ingenuity and resourcefulness of the person directing their installation.

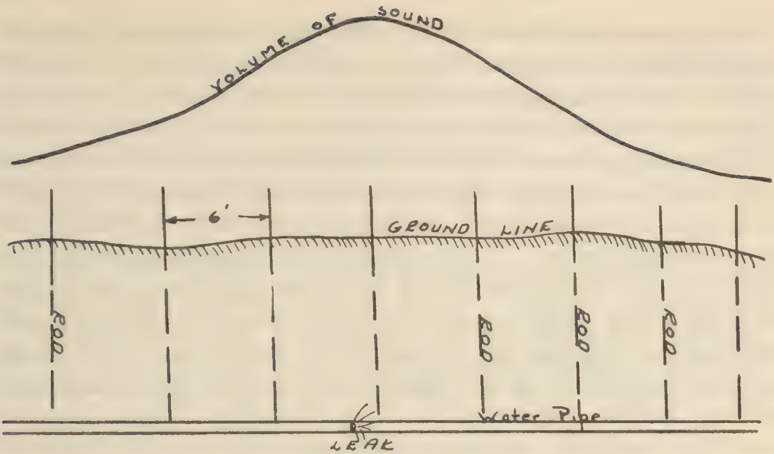
A reducing adapter coupling of this type is manufactured for the purpose of making permanent or temporary repairs to old cast iron pipe, using steel pipe or cast iron pipe of a different class. They are provided with a long hub permitting much latitude in connecting to a jagged end of a broken pipe and the eliminating the cutting of the pipe.

Bell Joint Clamps. A bell joint clamp is used to mechanically repair a leaking bell and spigot joint. It consists of an adjustable anchor ring that fits around the bell, an adjustable follower ring that encircles the spigot end, and gasket and bolts to connect the two rings. They offer a quick and practical method for the repair of joints to which they give additional strength and flexibility. Their installation will eliminate the necessity of periodically recalking certain troublesome joints that may be subject to heavy vibrations.

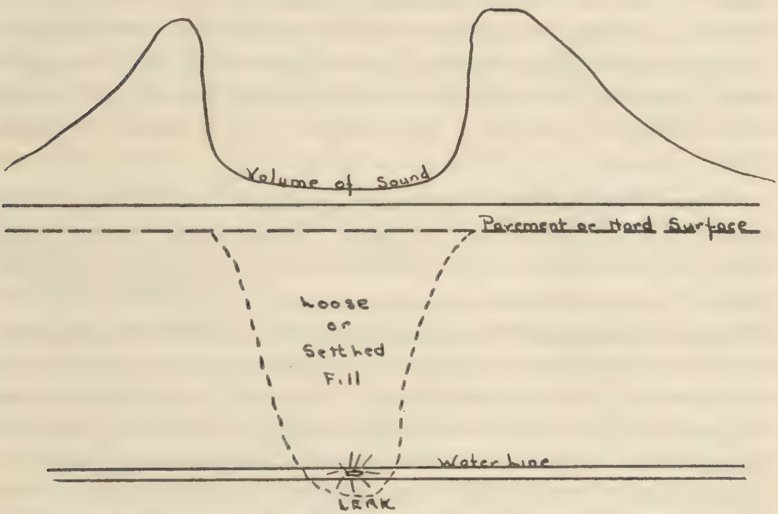
Emergency Pipe Clamps. They are used for quickly repairing small pinhole leaks in pipes 12-inch and less in diameter. They are made in two sections with an open hinge on one side and bolted on the other; a gasket completes the clamp.

Leak Detectors. The fundamental principles of the sound pick-up method of leak detection are based on the facts that any sound must have its origin in a vibrating body, that iron and water are good mediums for the transference of sound waves and that the amplitude of the vibrations or the volume of the sound increases as the source is approached. Water escaping under pressure from a broken or split pipe sets up vibrations in that pipe. The object of leak detection is to pick up evidences of these vibrations, to amplify them and to trace them to the source. This is done with the aid of an aquaphone or geophone which amplify the sound mechanically, or with one of the many leak detectors that electrically amplify the vibrations. Modern types of leak detectors use microphones, radio equipment, meters and head phones to pick up, amplify and register the intensity of the vibrations. Comparative readings are taken on the pipe, possibly with probe bars, valves, hydrants, curb cocks or on the ground directly over the pipe. With due regard for many variable factors, such as the depth and kind of cover, the size and material of the pipe, an experienced operator becomes very proficient in locating leaks. (See diagram.)

Valve Operating Machines. When a water main is broken it is of the utmost importance to quickly isolate the leak by closing valves to interrupt the flow of water. The valves may be operated manually by using a valve key and handle, but the repair work will be greatly expedited, especially in the case of the larger valves, if valve operating machines are available. They consist of some device for rotating a valve key and may be driven by an air-motor, electric-motor or by take-off from the engine of the truck to which it is attached.



ROD METHOD LOCATING LEAKS



VOLUME OF SOUND REDUCED OVER LOOSE OR SETTLED FILL SOLID SOIL TRANSMITS SOUND FURTHER

Charts prepared by R. J. Rowe, Superintendent, Wellsville

Excavating. If the excavation work is to be extensive in character, the saving in time and labor will justify obtaining any type of power excavating equipment that can be begged, borrowed or rented. Under the usual conditions, pneumatic digging tools are used extensively and effectively; but, due to the very nature of the work, there will always be plenty of old-fashioned pick and shovel work to be done.

Compressor and Pneumatic Tools. In consequence of its diversified applicability, no repair item is more important than the portable gasoline-engine-driven air compressor. It may be had in various sizes delivering from 60 to 500 cu. ft. of air a minute at 100 lbs. pressure, the size being chosen with due regard for the character of the work to be performed. It is furnished, mounted on two- and four-wheel trailers, on the truck chassis, and a type with power take-off directly from the truck motor. A trailer-mounted compressor delivering from 100 to 150 cu. ft. a minute will be found indispensable in saving time, conserving man power and in accelerating repairs. Its principal pneumatic accessories that are well adapted to many repair requirements are: the jackhammer, a self rotating drill that cuts holes through rock concrete and brick; paving breaker, for breaking through pavement, loosening hard soil and general demolition work; pile drivers, for driving sheeting; chipping and calking hammers, for speeding up the cutting of pipe and the calking and repair of lead joints; diggers for loosening of clay or any compact or frozen material; revolving wire brushes for quickly and effectively removing rust and scale from pipes; backfill tampers, tamp the fill and work around the pipe more thoroughly than can be done by hand methods; and the air-driven sump pump.

Pumps. The necessity of removing water from the trench will entail the use of some type of pump. The size and type of pump usually depends on what is at hand or what can be quickly obtained. Manually operated diaphragm pumps having a capacity of from 30 to 100 gals. per minute are frequently employed. Under emergency conditions it will be found almost essential to dewater the trench by means of a portable power-driven pump. The small centrifugal models weighing from 50 to 100 lbs. and delivering up to 250 gals. per minute will be found invaluable on any repair job. They are a self contained, gasoline engine-driven unit automatically primed and have a suction lift of about 25 feet. The larger models are mounted on two-wheel trailer trucks for portability and will deliver from 250 to 1500 gals. per minute depending on the size. The small pumps are at times mounted on the front of a truck, so that it operates directly off the crank shaft. An air motor-driven sump pump should be part of the compressor equipment. They weigh about 50 lbs. and have a capacity of 200 gals. per minute against a 10-foot head.

Sheeting and Bracing. To protect the work and the workman from cave-ins of the embankment, vertical hardwood timbers called sheeting are placed or driven about the trench at various intervals,

supported longitudinally by walers. Horizontal bracing across the trench is usually made up of timbers or small pipes with length adjusting jacks at either end. In some cases the sheeting is supported by inclined struts or shoring. The amount and the arrangement of the sheeting, shoring and bracing are entirely a matter of judgment and depend on the nature of the ground to be supported, the depth and the width of the excavation.

Derricks and Hoists. Pipes and fittings of the smaller sizes may be lowered into or removed from the trench by means of rope-slings. To facilitate the handling of the large sizes various forms of derricks, usually the three- or four-legged ditch type, and chain hoists are commonly used. The handling of the largest size pipes will involve the use of some type of power crane.

Cutting Pipe. There are three general methods of cutting cast iron pipe in the field. In one using hand tools the first cut is made with a diamond point chisel, and further cutting is done with a pipe-cutting chisel. Finally the pipe will become weakened to the point where it will snap off, making a fairly even cut. The second uses multi-wheel cutters, and is widely used for cast-iron pipe in diameters up to twelve inches. The third method utilizes the compressor and pneumatic chipping hammers. Machines have been invented for the purpose of cutting pipe, but they are not generally used in repair work. Steel pipe is cut with an oxy-acetylene torch. Cement-asbestos is cut with an ordinary saw.

Portable Floodlights. In anticipation of night repair work it would be an advantage to have available portable gasoline engine-driven generators for emergency floodlighting purposes. It may be a self-contained unit or a type that is mounted on the engine block of a truck and operated by the fan belt. They can be adapted to supplying current for electrically driving pumps and valve operating machinery.

Application of Materials and Equipment.

Now let us consider the application of these materials and equipment to the actual field work necessary to repair a break.

Break. A break in a water line may be defined as any fracture large enough to produce a dangerous loss of pressure or volume of flow. The least serious is a blown-out joint; next, a cracked pipe; and finally, a completely broken main. Breaks may be roughly divided into two classes: Major, Minor.

In general, a major break would be on a line of 12 inches or greater diameter supplying areas or communities some distance from the break. An example of a minor break would be a 6-inch main supplying a few residential blocks. There is no sharp line of division between a major and a minor break. For example, a break in a 6-inch main supplying a munition factory, which had no other supply, and would have to shut down, would be considered a major and be handled accordingly.

The following is a brief description of what happens when a major break is reported. The apparatus used is not fully described, as this very important feature is fully covered in another lesson.

Major Break. Notification of the general location and possibly some data as to magnitude is received from Pumping Station operators, Police, Citizens, Telephone, Radio, Messenger, at Repair Headquarters by Superintendent, Dispatcher, Foreman. The man in charge at Repair Headquarters studies the information received and from looking at the piping plans and his own knowledge of the location, decides in this case that a major break has occurred.

The Shut Down. The first job is to get the water shut off, because: (1) Very little progress can be made in repairs until this is done. (2) The water being wasted will deplete the storage in reservoirs, tanks, standpipes, etc. (3) A large volume of escaping water may damage highway structures and flood cellars in the neighborhood.

So the dispatcher gets a crew together. In most cases at least two valves must be closed to complete the shutdown and the number may run as high as a dozen or more. Therefore, more than one crew is often desirable. At any rate, one is sent as soon as possible, made up of emergency men on duty or called in from their homes or other jobs. In addition to transportation, hand operated keys for turning down the valves, and power operated valve turning machine, the crew is provided with a plan showing the location of valves requiring closing. Such plan should have ties or references from the valve box in the street or highway to nearby, easily recognizable objects, for, although the valve box may be normally located by sight, it may be also buried in snow, ice or street repair excavation. If such a condition can be anticipated, it is desirable to include a portable air compressor with tools in the equipment. The dispatcher also notifies the pump station operators to be on the alert, as the valves are closed, to expect a change from abnormally high pumpage to a pumpage possibly much lower than normal. He will then take the proper steps to prevent a sudden building up of pressure as the final valve is closed. If this is not done, other mains may burst from excessive pressure.

In locating the valve boxes, when covered, a dip needle is a very valuable tool. When the last valve is closed the men go to the break. Inspection shows if a complete shut-down has been made. If the water is still boiling out of the hole, it usually means that some necessary valve has been forgotten, or a valve has been closed and the by-pass valve left open, or even may indicate a defective valve. Then it is necessary to locate the valve that is giving the trouble and properly close it. If this is not possible, another valve or valves farther away must be found and closed.

In the meantime, repair crews are sent to the break. Even though the water is still boiling out, some work can be done. Some of the following problems usually come up: Can power excavation machines be used? If so, can they get to the site or will obstructions such as parked cars, wreckage, broken poles, wires, etc., have to be removed first? What kind of power excavation is best adapted—clam, back hoe, hand work, or a combination of machine and hand? What kind and how much material will be needed? The foreman can often make a good guess as to what pipe fittings and sleeves will be needed and precious time saved by obtaining them from storehouse and pipeyard.

Unwatering. After the valves are all closed and the rush of water is stopped, then comes the problem of unwatering. There is still a hole or crater full of water, and dead water lying in the mains, which has to be removed before effective excavation and repairs can be made. This is accomplished by pumping.

In general, centrifugal pumps will handle large volumes of comparatively clear water, while diaphragm pumps are best adapted to water containing a high percentage of mud, sand, loam, etc.

Sheeting and Bracing. Some soils can only be excavated a few feet before they cave in and even the stiffest soil will not stand up long when wet. Bracing and sheeting is usually of wood. Cross bracing is usually done with trench jacks, which are adjustable, flexible and easily placed. However, when there is plenty of power-excavating equipment handy it is often quicker to slope the sides of the trench back at a flat angle until the earth gets its natural slope and will not slide into the hole. This requires the moving of a lot more yardage but often saves time over the sheeting method. Another time-saver is to excavate a hole to one side, deeper than the main—this acts as a sump to gather drainage water seeping in from the saturated ground around the hole, and also collects any water still coming out of the mains. Into this sump the suction end of the hose is put and connected to a ditch pump above.

Repairs. The uncovered main will probably be found to have one of the following: (1) a crack across the main (2) a crack along the main (3) a complete fracture.

1 A cross crack can be repaired with a split sleeve.

2 A crack along the pipe can be repaired with a split sleeve, if the sleeve is longer than the crack. If the sleeve is not long enough, the pipe has to be cut off well outside the crack. Usually a full length is cut out and repairs are made (see 3).

3 A complete fracture is cut off on the good pipe and the gap filled with new pipe. The joints are made up with a solid Cast Iron Sleeve or with a special Steel Sleeve made tight with rubber gaskets and bolts. The latter material is quicker and gives a positive job. It has the advantage over a poured joint in that a good make-up can be made in the presence of a considerable flow of water. A poured joint that is not dry is risky, and failure uses up valuable time in cutting out and repouring the bad joint.

In addition to the three types of failures just described, there is a fourth type which might be called a series of breaks. Example: (a) Floods washing away several hundred feet of main in a stream bed. (b) A bridge which carried a water main being completely demolished. (c) A whole section of main sliding into an adjacent excavation, such as a sewer ditch. These are abnormal disasters and it is often necessary to lay temporary surface lines and connect into the uninjured ends of the destroyed main. Special methods, adapted to the situation, have to be worked out on the ground.

Sterilization. The hasty repairs of a fractured main are likely to produce contamination at the site of the job. This situation is aggravated if sewers are broken at the same time. The way to sterilize was described in Lesson 5.

Putting Main Back in Service. This is the opposite of unwatering. The repaired main is empty of water and full of air. The problem is to get the water in and the air out as quickly as possible, without damage to the water main, services or hydrants.

The air is gotten out of the main by opening hydrants and faucets in houses. If these are not available, then taps are made in the main at the high points. One of the valves, previously closed, is opened slightly. The amount the valve is opened is a matter of judgment, partly governed by the available outlets for air. The valve selected

for filling the line is usually the lowest one in elevation, as it is good practice to fill from the bottom and force the air out at the high points.

As the water rises in the main the lower hydrants stop blowing air, usually blow air and water intermittently and then blow all clean water. Then they are shut off one by one until the line is under full pressure. Then the joints at the repair point are inspected for leakage. The pumping station operators are now informed that the break has been repaired and they take the necessary steps to start additional pumps as the load comes on; now all valves previosuly closed are opened and service is resumed.

The repairs just described may have taken 12 hours, 24 hours or a week. If additional relief crews are available, the men have worked in relays with some time off for sleep. If there are no relief men available, the men have been on duty continuously, food has taken the place of sleep. So when the broken main is placed back in service, the working force is usually pretty tired. Therefore, backfill, repair of broken pavements, etc. is left until the next day or taken over by other forces.

General Conclusions and Comments.

In a major break it is to be noted that SPEED is the controlling factor. The reason for this is that:

1 The entire district inside the closed valves is entirely out of water. Also adjacent communities may be out of water if the broken transmission line is their supply.

2 The area affected is under an enormously increased fire hazard, as the firemen are now limited to the use of chemical extinguishers and the small amount of water carried in booster tanks. Also the same explosion that broke the water main may have started fires in the vicinity. These fires may burn virtually unchecked until water service is restored.

3 A complete or partial shut-down in all manufacturing establishments may be necessary. This is especially true of all machines or apparatus using water directly or indirectly as cooling water. Some processes require water delivered at a certain pressure. Even if the supply does not fail, a reduced pressure may make a shut-down necessary.

4 Any munition factory, airplane plant or essential industry may be entirely shut down, or enough departments may be shut down or seriously handicapped to throw the entire production alignment out of gear.

Therefore, speed is the main factor. Cost and efficiency are secondary. For example, duplicate manpower can be used at high speed by alternating heavy work and rest periods. Spare pumps are valuable if they just stand at the site of the break, ready for instant use in case an active pump goes sour.

Minor Breaks. The main difference between a minor and a major break is in the magnitude of the disaster. (1) The size of main is small. (2) The area valved off is restricted to a few blocks at most. (3) The material, power machines and manpower involved are less. (4) The fire hazard is less, as hose lines can be run from hydrants on adjacent streets. (5) In some cases the consumers can be notified to draw water before shutdown.

Therefore, it is possible to apply more efficient methods of repair. The manpower can be assigned to properly do the job economically. For example, one crew, one truck, one compressor and one pump may be enough to do the entire work from "shut-down" to "back in service".

Leaks. In naval warfare, bombs dropped from above may be divided according to their accuracy into: (1) Direct hits (2) Near misses (3) Misses.

The "near misses" may do considerable damage and even sink a vessel.

In the same way, land bombing may damage a water main so as to create bad leaks at a considerable distance from the hit without any breaks. If the main happens to be in or near rock, the leakage may not give any surface indication. Where there is no rock it is possible that the leakage may find its way into a sewer and not show on the surface.

However, if the master meters at the Pumping Stations show pumpage above normal, a general check of hydrant pressures and sound indications in the area under suspicion will show the approximate location of the leak or leaks. The problem is to get an exact location and make the necessary joint repairs. Two outstanding devices are now called into service:

1 *Pipe Locator.* The two general types are (a) the closed circuit by direct connections to the main, hydrants or services. (b) The radio type, which requires no attachments and has a transmitter and receiver.

2 *Leak Detector.* There are various types of leak detectors, but all depend on amplifying and receiving the typical hiss that

water makes when escaping through a small opening. The above devices require skilled operators.

Notes on an Actual Major Break.

The foregoing description of a major break in general tells the story of the application of material, men and machinery in the field repairs but does not tell the whole story by any means. What goes on behind the scenes at many points distant from the site of the disaster can best be illustrated by brief notes taken from a complete report on an actual major break in the western part of New York State.

A large transmission main cracked near the bank of a stream crossing on a State Highway route, under a 23 ft. fill in the first week in March, which is still Winter in this latitude. As this main carried 70% of the load to the general system beyond the break, it is obvious that it was necessary to make the remaining 30% go as far as possible and supply the deficiency as much as possible from other sources. Trying to force water through the remaining 30% of the transmission system at increased pressure only blew up mains between the pumping station and the break, thus putting an additional burden on the repair personnel. To offset the rapid depletion of storage in tanks, standpipes and reservoirs, the following steps were taken:

1. Arrangements were made with an adjoining City for temporary emergency supply water. This was done by selecting two points where hydrants of each system were fairly close together, laying fire hose and pumping with fire pumpers. Two pumpers were secured, one from the City and one from a Town. One pumper was in continuous operation for 100 hours and the other for 96 hours.
2. A large village and a township located at the extreme end of the system farthest from the break, were supplied directly through emergency connections.
3. A large railroad supply point at the extreme easterly limits of the system had an emergency connection to a small stream. They put their pumping station in operation during the emergency.
4. A large public institution in the same vicinity had their boiler feed-water pumped from the same stream by the local fire company and were supplied daily with bottled water by the ton for drinking and domestic use.

5 Large advertisements were printed in the daily papers requesting all consumers to curtail their use of water during the emergency.

Meanwhile, at the break, conditions were going from bad to worse. Heavy rains put the stream in flood stage and over its banks. The excavation hole filled up faster than it could be pumped out. On the third day plans were made to by-pass the break with an emergency surface line. This required nearly 1100 ft. of pipe, 3 large valves and the necessary fittings to connect from the underground mains to the surface line. Excavation was started at both ends at the connecting points for the surface line. Work at the south hole proceeded slowly because the underground main was 11 feet below the pavement, there was over 3 feet of frozen ground and the highway fill, through which the excavation proceeded, was made up of loose rock, pieces of concrete, brick, etc.

While end excavations were proceeding, the surface line was laid. Seven hundred feet was laid in one night. The weather was bitter cold and a high wind blowing. Although blizzard conditions were faced, excellent progress made. Necessary valves were cut in, the balance of the surface line was laid and on the sixth day the new line was chlorinated and put in service. The fire pumps were shut down after having made records for continuous operation under severe working conditions. The storage was gradually built up in depleted reservoirs, standpipes and tanks. The pumping stations, which had been shut down, were put in service. Pressure and supply were soon brought up to nearly normal operating conditions.

Meanwhile, a liberal use of dynamite on the ice jams downstream from the break had opened up the stream flow, the flood subsided. The extreme cold helped to check the flow and froze the banks of the hole at the break, allowing excavation to proceed rapidly. The break was found to be a cracked pipe in a rock trench 23 feet below the highway surface. On the ninth day repairs were made and the old line placed in service.

Therefore, when and if the emergency comes, we have the right kind of human material that can "take it" and turn out a job.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 6

To be reproduced locally for distribution to Class Members

General Repair Technics

A public water supply finds very important use in the extinguishing of fires. Frequently, the capacity of a water works distribution system is controlled by fire protection demands, which exceed the rate of consumption of water for domestic needs.

It must be emphasized strongly that accurate maps and records are a prime necessity in order that there may be efficient operation and maintenance of a distribution system. The various components of a system, mains, valves, etc., should be clearly noted as to location.

Many times it is imperative to check the location of a main. This check can be obtained through the use of a pipe locator. A dipping needle acts as a locator of covered valves and curb boxes. Quick detection with this device is not possible when a valve or curb box hides under more than a foot or so of earth or other material.

Reduced to simplicity, a distribution system is composed of a great number of lengths of pipe connected by a great number of joints. A variety of materials have been used in making pipe. Each material has its advantages, depending on requirements and use. Cast iron pipe is predominantly used today. It has proven durability and it meets the requirements of strength and moderate cost.

Buried cast iron pipe is almost universally connected by means of the bell and spigot joint. Lead has been the chief material used in jointing for this type of joint. But now there are many satisfactory substitutes which have the advantage of requiring no calking.

There are other types of joint, each with its particular use and advantage. Some of these are the flanged joint, the universal joint and several types of mechanical joint.

Special castings called fittings are available for cast iron pipe. These fittings are used for the purpose of changing the direction of a water line, varying the size of the line, or making branch connections.

Plugs and caps are used in bell and spigot joints to close off sections of pipe and to cap dead ends permanently.

Steel pipe has several advantages over cast iron pipe:

1. It is stronger and lighter.
2. It can be fabricated in longer lengths.
3. It has fewer joints and is easier to handle and transport.
4. It is especially adapted to long transmission lines and large trunk mains with only occasional side connections.

Asbestos-cement pipe has the following advantages:

Lightness of weight, ease of handling and cutting, no need of calking, and resistance to corrosion, but is less resistant to fracture than metal pipe.

The service pipe is the small lateral connection between the main and the property being supplied. This connection is achieved by means of a valve called the corporation cock. The corporation tapping machine makes taps and inserts cocks ½ inch to 2 inches in diameter in mains under pressure. Connections exceeding these dimensions are made by cutting out a section of pipe and sleeving in a tee or by using a tapping or drilling machine.

Sleeves are of two types—split sleeves and solid sleeves. Couplings are a variation of both types of sleeve. Their numerous applications are limited only by the ingenuity and resourcefulness of the person making or directing the installation.

Bell joint clamps and emergency pipe clamps are used to repair leaks.

When a water main is broken, it is of the utmost importance to isolate the leak quickly by closing valves to interrupt the flow of water. This closing may be done manually or with a valve operating machine, a device for rotating a valve key.

Extensive emergency water main repairs generally require the employment of some if not all of the following equipment: power excavator, pneumatic digging tools, portable gasoline-engine driven air compressor with accessories, some type of pump, shoring and sheeting material, rope-slings, derricks, hoists and power cranes.

There are three general methods of cutting pipe in the field:

1. With diamond point chisel and pipe-cutting chisel.
2. With muti-wheel cutters.
3. With compressor and pneumatic chipping hammers.

Steel pipe is cut with an oxy-acetylene torch.

A break in a water main may be defined as any fracture large enough to produce a dangerous loss of pressure or volume of flow

in a water main. Roughly, breaks are classified as major and minor, although there can be no sharp line of division between major and minor breaks.

The general procedure in the event of a major break may be outlined as follows:

A Notification of the general location and magnitude and determination of the major break from a study of maps and records.
B Assembling of repair crew or crews, supplying of plans to crew, showing location of valves requiring closing and shutting off of water.
C Advising pumping station operators to be on the alert for valve closing.
D Locating the breaks and supplemental breaks accurately.
E Appraisal of the extent of break, obstructions, etc.
F Unwatering through the use of pumps.
G Excavating.
H Sheeting and bracing.
I Appraisal of type of break.
J Repairing—four types of break.
- *1* Crack across the main.
- *2* Crack along the main.
- *3* Complete fracture.
- *4* Multiple breaks or fractures.

K Sterilization.
L Putting main back into service.
- *1* Removing air from main.
- *2* Inspection of joints at point of repair.
- *3* Notifying pumping station operators of resumption of service.

M Backfill, repair of broken pavement, etc.

Speed is of prime importance in the repair of a major break because:

1 Water service is closed off to household consumers.
2 There is enormously increased fire hazard in the area affected by the break.
3 It may be necessary to shut down service to war production plants.

The foregoing description of the procedure relating to a major break is a general story of the application of material, men and machinery in the field repairs, but it is not by any means the complete story. Actual cases will have individual problems which must be solved through the application of ingenuity and resourcefulness.

CLASS LESSON NO. VII

Temporary Repairs to Broken Water Mains

SYLLABUS FOR CLASS TRAINING SESSION NO. 7

2 Hours

Subject. Temporary repair of broken water pipes.

Instructor. Instruction preferably should be given to a combined group of auxiliaries from all towns and villages in the county. An outstanding superintendent experienced in repair operations and familiar with technical literature on the subject should serve as instructor.

Scope. *First hour:* Lecture on the detailed methods of making repairs in a bomb crater where both water and sewer lines have been broken. Lecture should describe the methods of making temporary connections between fire hydrants through hose line, method of dewatering crater and effecting temporary repairs to sewer line, followed by method of making water repairs through bridging of crater or by-passing of crater using either new lengths of pipe or sleeves. Procedure for disinfecting the repaired line, testing, etc., before restoration of water service should be included. Use prepared charts, blackboard sketches or demonstration set-ups to illustrate methods.

Second hour: Discussion, outline of the solution of additional problems, and oral quiz.

Assign for reading prior to lesson No. 8 some article from current technical literature relating to water main repair methods.

Reference Text for Lesson.

Introduction.

Under emergency conditions the demand for water supply for fire fighting and sanitary purposes is at a maximum, therefore the necessity for a thorough knowledge of the methods used in making emergency repairs cannot be too strongly emphasized.

Since prompt restoration of service is so essential, it must be recognized that this result can only be attained through the combination of well trained workers and an adequate supply of proper materials and equipment.

Since this lesson will cover the repairs of a temporary and emergency nature, the work will be concerned largely with mechanical fittings, namely, those not requiring poured joints. When mechanical fittings are not available, it will be necessary to resort to standard fittings with poured joints.

Although mechanical fittings are associated here with temporary repairs, it is not meant to imply that they are not permanent in nature, but rather that the particular use is of a temporary nature. Most mechanical fittings are considered as permanent units and if the location of the unit does not require a change at some later time, it may remain permanently. Should the temporary repair require a more permanent relocation, mechanical fittings may be completely salvaged for future use.

The work covered will be confined to average size water mains, as the repair of very large water mains is considerably more involved, more highly specialized and is much more dependent on heavy equipment.

The fundamental ways of repairing mains have not materially changed during the course of years, except that repairs are now made in shorter time through the use of improved equipment, better trained employees, and improved transportation facilities.

In any incidents where time permits, a preliminary investigation of the damage should be made with a view towards lining up the repair jobs in the order of importance, and also to estimate the requirements as to number of men, materials and equipment required. A preliminary survey can save much valuable time that can be expended in taking care of a larger number of incidents than would otherwise be possible.

Preparation for Repairs.

A **Report.** There are many different ways in which leaks from broken mains might be detected, but let us assume that any leak resulting from a war incident would be reported through regularly organized channels, such as Air Raid Wardens. The report would at least give some detail as to location and might give some indication as to magnitude.

B **Investigation.** Well trained men are unquestionably the most important factor, for without them no work could be accomplished. Previously designated assembly places should be arranged in order that the men can be picked up for transportation to the site of repairs.

The first concern on being advised of a broken main is to send out a crew for investigation as to the exact location of the leak and for shutting down valves to stop the flow of water from the affected area. This crew should be composed of two or three men, and at least one man should have a thorough knowledge of the water distribution system and the use of several instruments commonly used to determine the location of a water main break. In the absence of exact information as to the location of the rupture in the pipe, the first effort is directed toward determining the point of the break within reasonable limits, or at least between specific gate valves. One of the instruments most commonly used is the ordinary telephone receiver unit which amplifies the sound caused by escaping water, this sound being carried along the pipe line. In making an investigation of an area, the operator would listen with this instrument on all hydrants, gate valves and curb shut offs in the general section. The unit giving the greatest intensity of sound would most likely be nearest the point of rupture. The instrument requires some degree of interpretation and an operator of the instrument becomes more valuable in proportion to his experience.

Another instrument very commonly used is the magnetic dipping needle for locating gates, valves and curb boxes which are not immediately apparent. The use of this instrument is very simple, although it is not intended to replace valve location records but rather to be used in conjunction with complete and adequate location records.

A third instrument of fairly common use is the "aquaphone" or "geophone", an appliance which is similar in principle to the physician's stethoscope. This instrument is used to determine the location of the leak by observing the point of greatest vibration reflected to the ground or road surface. Its use is generally quite effective on hard surfaced roads such as concrete and brick, but is not particularly effective on macadam or dirt roads. Much of the success in the use of the instrument is dependent on the experience of the operator.

There are several other instruments of more complicated design used in leak detection but there is little likelihood that they would be required or used in connection with major leaks resulting from a war incident.

It might also be necessary to use one of several types of instruments designed to locate the line of the water pipe, these being referred to as pipe locating, or pipe finding instruments. The general use of this type of instrument is fairly simple and they are reasonably accurate.

C **Shut Down.** Having confined the broken water main to within reasonable limits, little time should be lost in shutting down all gate valves necessary to discontinue the flow of water to the point of the break. Although in normal operation it is customary to notify consumers of intention to disrupt the supply, it is not presumed that any time will be devoted to this in a war emergency.

Actual operation of gate valves is fully covered in another lesson, but it should be emphasized that extreme care in handling is demanded in order to avoid further damage to the distribution system.

Should difficulty be experienced in quickly determining the general location of the leak, it might be necessary to shut down the supply to a whole general area to stop the loss of water and to follow this with further investigation to confine the area shut off to within more narrow limits.

D **Protection.** Having determined the location of the break and shut off the supply of water, the first crew have completed their work and should report their findings.

Many leaks result in the creation of traffic hazards, and protection through the use of barricades and safety lights should be provided immediately. It is reasonable to assume that we will profit by the experience of England and not attempt the repair of broken water mains except in daylight. If repairs are to be made without daylight, it will be necessary to provide emergency lights, of which many satisfactory types are available.

E **Materials.** The quantity and type of material quite naturally varies according to the nature and extent of the damage. There are, however, generally accepted standard repair items such as sleeves, adapters, reducers, bends, offsets, split coupling clamps and numerous patented fittings in a variety of sizes which should always be on hand in any well managed system. Every Supervisor engaged in water works operation should be thoroughly familiar with all types of repair materials, even though they are not used in his particular system, for such knowledge may be of later value in making interconnections with other systems or in rendering aid to outside systems.

Experience has shown that so called "mechanical fittings" and mineral compounds for joints have proven the most efficient where speed is concerned, and it may be stressed that these items, when properly used, result in repairs of permanent nature.

In discussing material, the need for proper handling of materials and especially of fittings is of particular importance, since much valuable time can be lost through defects caused by careless handling.

F **Labor.** Quick and effective repair of broken water mains requires an abundance of good laborers. These men should be in good physical condition, preferably with previous experience in ditching work and ability to handle heavy objects. At least three laborers are usually required for each mechanic or skilled worker.

G **Equipment.** When repairs are to be undertaken, it will be necessary to dispatch a truck to the site to transport all the necessary men, material and equipment required for the prosecution of the work. Details of the required materials may not be completely known until the work progresses, but many items of equipment are used in every repair job. The repair truck should always be equipped with these units and any special equipment required may be brought to the work when needed. Consideration should be given to the advantage of having the equipment located at several points, so that it may be on the scene of repairs promptly.

Types of Breaks.

A **Transverse Crack.** One of the simpler types of breaks in water mains is the transverse crack or break which goes directly across the water main or at a slight angle. This type of break may go partly around the pipe or completely around. During an actual bombing attack many breaks of this type might be experienced due to demolition bombs falling nearby, but not as the result of direct hits. The repair of this type of break is the most simple of all repairs.

B **Longitudinal Cracks.** Another common type of break is the longitudinal crack or break which goes along the line of the pipe. This break may extend only a few inches or involve a whole length of pipe. This type of break usually requires the actual removal of at least a portion of a length of pipe. Many breaks such as this might also be experienced due to demolition bombs in the immediate vicinity of water lines.

C **Major Breaks—Craters.** The most common type of break resulting from the bombing of English cities was the break occasioned by a more or less direct hit and disruption of the water mains within the limits of bomb craters. This type of break usually involves the replacement of several lengths of pipe and the repair may be considerably involved for many reasons.

D **Other Types.** There are several other types of breaks which might be encountered, such as the pulling out of taps, blowing out

of sand holes in cast iron pipe, blow-out of a section of pipe, etc., but only the more common types will be discussed as the actual repair work is little different.

Repair of Simple Breaks.

A **By-Pass Service.** In the repair of a simple break, consideration might first be given to providing by-pass service around the affected area, although this is more likely to be required in a major break. The repair of a simple break often allows a reduced volume of water to be available, since it is not always necessary to completely shut off the main. Whenever the loss of water is not too great, it is often advisable to leave one gate valve slightly open to allow some pressure and a small flow of water in the main.

B **Pavement Removal.** If the location of the break has been definitely established, the pavement or road surfacing should be removed over a sufficient area to allow ample room for the repair men to perform their work. The removal of concrete pavement or other hard surfaces is time consuming and invariably requires adequate equipment. If the location of the break is not definitely established through the use of instruments, it is often advisable to drill holes through the pavement along the line of the pipe and to carry these holes down to within six or eight inches of the pipe. Observations may then be made by probing with a small crow bar. Different soil conditions require various adaptations of this procedure.

C **Excavation.** The area of the pipe to be exposed through excavation is dependent on the type of repair. Care should be exercised to determine the exact location and nature of the break before performing any unnecessary excavation.

Many types of soil require at least skeleton bracing to prevent caving-in and this is especially true after the soil has become saturated with water. Every foreman of a repair crew should keep the safety of his men foremost in his mind at all times. Occasionally complete sheathing may be required.

D **Pump Operations.** Unless the escaping water has been carried away by some type of drain in the immediate vicinity, a trench pump will most likely be required, even during the excavation. This is especially true if a tight shut off is not desirable or cannot be secured. The opening of hydrants for draining sections may also be advisable to relieve pumping operations.

E **Type of Repair Fittings.** As mentioned previously, the most simple type of repair is required for a transverse break. Frac-

tures of this type can be quickly repaired by the use of the split sleeve with poured joints, but are generally repaired by using one of the various types of mechanical fittings provided especially for such purposes. These fittings are usually of the split clamp type and use rubber gaskets which are applied by compression created by tightening the bolts of the sections. The most commonly used fittings are those of the Dresser and Skinner type. These units are small and inexpensive and when placed properly are considered a permanent installation.

Since these fittings are made in sections which bolt together, a minimum of excavation is required for their use. Their effective use is dependent on tremendous pressure applied to a rubber gasket and the water main should therefore be carefully cleaned. The average fittings cover only from four to six inches along the pipe and therefore are not adaptable to breaks which are not well confined within these limits. However, some mechanical fittings of more extensive length are available.

A more complicated repair is required for a longitudinal break, which is along the pipe rather than across. This type of break requires the removal of a section of pipe, often involves one end of a length of pipe and occasionally a complete length. The damaged portion may be removed most effectively in average size pipe through use of a pipe cutter, and careful observation should be made to assure that all of the damaged section is removed.

Having removed a damaged section of pipe, a new piece may be cut for replacement. If the new piece is a straight nipple piece, it should be cut about two inches shorter than the clear opening, in order to allow for one inch clearance at each end. Mechanical fittings of a solid ring type are available for this particular repair and one may be slid over each end of the existing pipe before placing the new section. The fittings are then centered over each joint and bolted firmly in place. The sectional type of mechanical repair fittings mentioned previously may also be used if no more suitable type is available.

Most mechanical or bolted fittings are equipped with a sizable drain plug so that any existing pressure may be relieved through the drain while the fitting is being placed. This may also be used for a vent.

Leaking beli and spigot joints may be repaired by cutting out the old jointing material, reyarning and replacing with mineral compound or lead. If only one leaking joint were involved, a quick permanent repair could also be made by applying one of the mechanical

fittings produced for this specific purpose. Such fittings are usually of the clamp and adjustable type, using rubber gaskets compressed by tightening the bolted sections.

Special types of mechanical fittings are also available for broken bells, pipes other than cast iron and for many other uses.

If mechanical fittings are not available or poured joints are required for any other reason, standard cast iron solid sleeves or split sleeves may be used. These units are placed in much the same manner as mechanical fittings, except that they require the pouring of joints.

If no sleeves are available, a short section of pipe one size larger than the pipe to be repaired may be used as a solid sleeve with poured joints, but a standard cast iron solid sleeve provides a much more desirable repair.

F **Restoration of Service.** Adequate sterilization of pipe lines should be the first concern after completing a repair job and this phase of the work will be covered elsewhere.

The pipe line should be refilled slowly by operation of one valve only and care exercised to relieve air entrapped in the main from all high points. Whenever possible, water should be fed into the main through the valve at the lowest elevation. Careful filling may require intelligent operation of hydrants in the affected area and occasionally beyond that area.

After the main has been completely refilled with water and complete pressure has been restored, the repair work should be observed for leakage. If all bolts on mechanical fittings have not been tightened firmly, additional tightening will be required after restoration of complete water pressure.

All valves shut down to permit repair work should be completely opened after testing in order to allow full volume of water to be available at the earliest possible moment.

G **Backfill.** Satisfactory backfill requires that the repaired pipe should have a firm, even bearing, and this necessitates selected material being placed under the pipe. The material should be worked around the pipe, well compacted and all voids filled. Reasonable care should also be exercised in the selection of fill to be placed above the pipe. Mechanical tamping of backfill should always be used whenever available.

A temporary surfacing material should be placed over the excavated area and all surplus material removed. The site of the work should be completely cleaned up as soon as possible after completion of the work.

Repair of Major Breaks.

Introduction. It is recognized that the fundamental methods used in making repairs to water mains are essentially the same, regardless of the size of the damaged main, but it is also evident that the incidental problems created by an incident such as direct or near bomb hit merits special consideration as a major problem, because of the difference in conditions under which the repairs are made.

For the purpose of this discussion let us assume that we have encountered an incident involving a twenty-five foot crater, where both the water and sewer lines have been broken from a direct bomb hit.

Our essential requirements of men and material would naturally be increased in proportion to the size of the damage and heavier equipment would also be necessary.

We shall now proceed with developments at the site of the crater.

A **Inspection.** A survey would be immediately made to determine whether additional or outside help, materials or equipment would be necessary to handle the situation and, if so, prompt arrangements made through proper channels.

B **Organization.** The trained personnel, divided into two groups, would operate in their previously assigned manner.

1 Men assigned to close valves.
2 Men assigned to by-pass operations and repairs.

C **Preliminary Operations.**

1 Barricades are placed around openings.

2 All valves in the area around the break are closed to stop the loss of water, particular care being taken to close the larger size valves first, to prevent any unnecessary damage to mains still in service. Up-to-date maps of distribution systems showing locations and sizes of mains and valves are referred to in these operations.

3 Simple by-pass service is arranged through a fire hose connected to hydrants located beyond damaged area, and water for drinking and sanitary purposes is arranged through a fitting placed on a hydrant in a convenient location.

4 Excavation operations are started, using power-operated equipment if available to remove all debris, broken pipe, etc.

5 Pump operations are started as soon as possible, using the most powerful portable pumps available in order that the de-watering be completed as soon as possible.

6 Examination for fractures or joint leaks in sections of pipe each side of the crater are made by use of leak-detectors or similar instruments. These tests are made for distances of at least 100 feet each side of the break and are carried out during the excavation and pumping operations.

7 Plug sewer and water lines by use of wooden or cast iron disc plugs as soon as possible, in order to prevent further flooding or contamination in excavation.

D **Operations to Restore Service.** Our preliminary operations being completed, the next operations are concerned with the repairs for restoration of service; and the type of repairs would vary in nature according to the urgency of the particular situation.

It is advisable to keep in mind that night repairs are usually not practical in war operations, because of the danger that would accompany the use of lighting equipment, and that makeshift arrangements of temporary nature should not be considered unless the conditions and emergency warrant such action.

We shall now proceed with several types of repair installations in the crater which has been excavated and dewatered, and assume that our examination discloses that the only damage was the demolished pipe in the crater.

Our operations would be as follows:

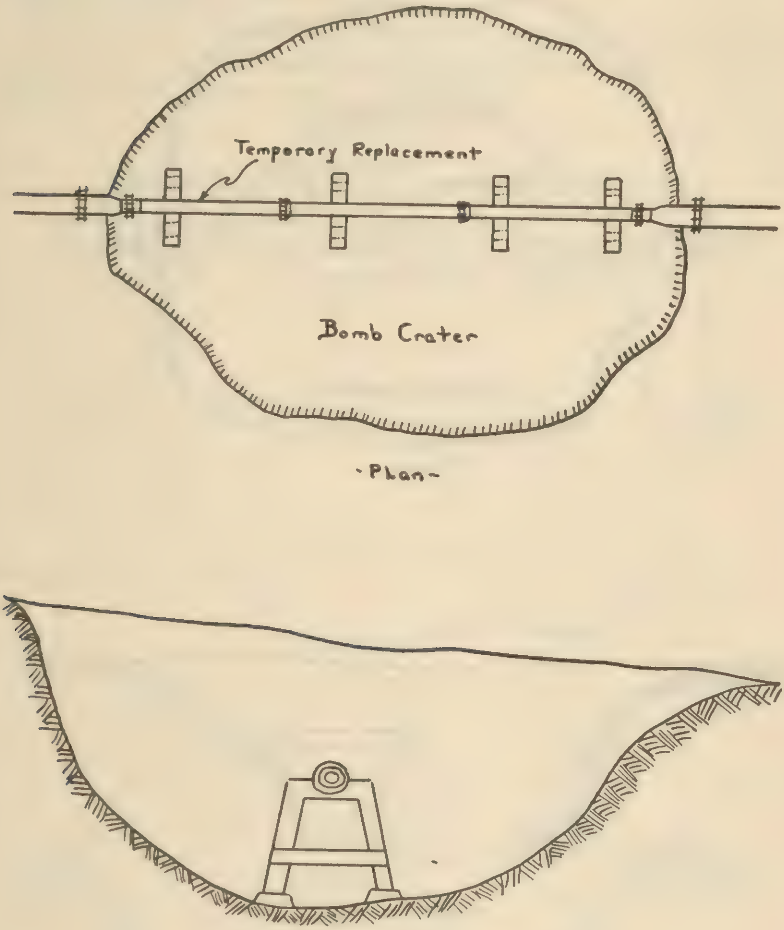
1 Wooden, steel or similar sheeting material would be placed around the sides of the excavation to prevent further collapse, and beams placed across the opening to brace the sides.

2 The bottom of the crater is leveled and beams or piles of wooden blocks arranged in rows across the crater at the proper height to support a new section of main.

3 The jagged ends of the old main are cut evenly or adapter sleeves applied over the jagged ends, so that permanent repairs of the same size pipe can be made in the same manner as described previously in our discussion of minor repairs.

4 After completion of the repairs the backfill can be completed immediately if the sewer repairs had been completed or it can be deferred until later. *(See Fig. 1)*

When extensive craters are encountered, involving damage to several sections of pipe, it might be necessary to locate the repaired section in a temporary position along one side of the slope of the



- Section -

Figure 1

crater, until such time that effective backfill of the crater may be made and the pipe line replaced in its original position.

England has had much experience in this type of repair and most of the repair work has been performed by using a mechanical joint pipe and bends and mechanical adapter sleeves. Material of a similar type has been made available in this country.

The adapter sleeve is provided with a hub that is long enough to cover a jagged break, and cutting of the existing pipe is unnecessary. It will fit practically all classes of cast iron pipe and is furnished in reducing sizes, so that it is possible to make all emergency repairs with one standard size of mechanical joint pipe. Quick and easy assembly is possible under all conditions, as only a wrench is needed for installation. Upon permanent repair of the pipe line, all mechanical pipe, bends and fittings may be removed for further emergency use.

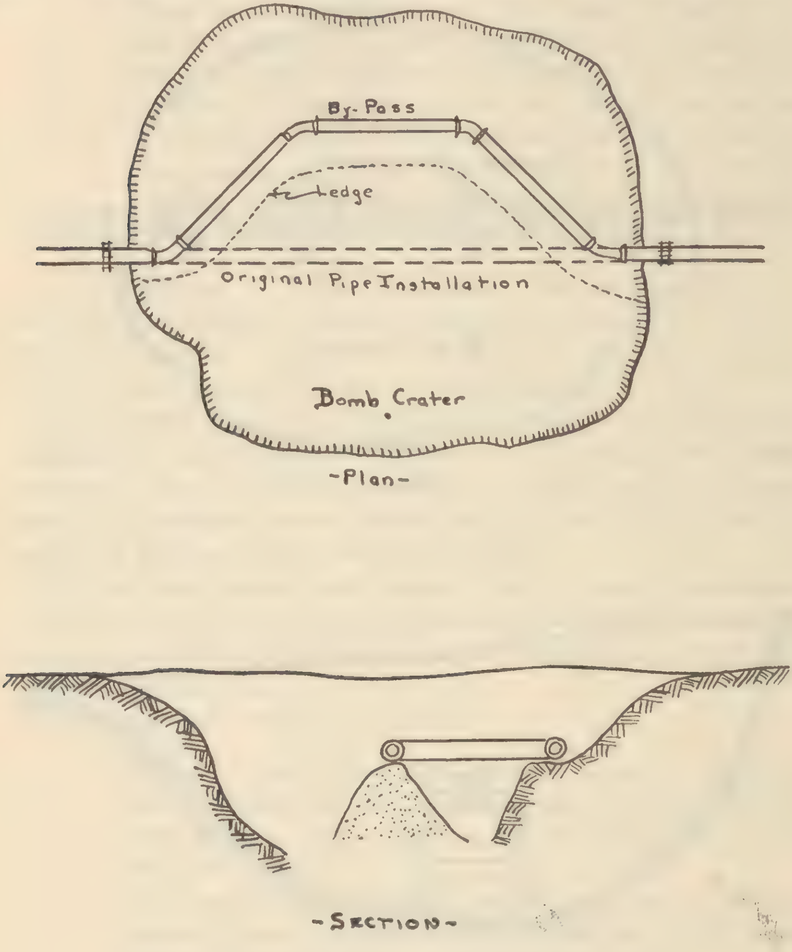
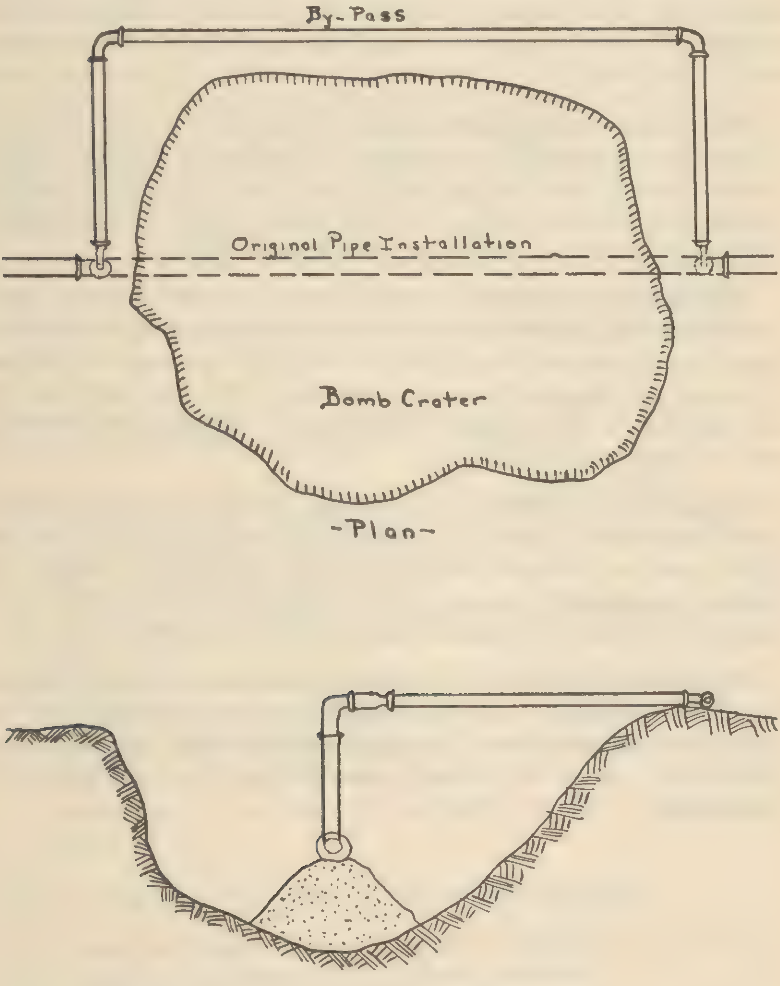


Figure 2

In addition to the adapters, this type of mechanical joint fitting is also available in split sleeves for repairing short breaks or joining two pipe ends together, and in mechanical plugs and caps. The special adapter sleeve may also be used as a cutting-in sleeve for installing valves and tees.

An important consideration in installing this type of temporary repair is to provide adequate bracing and blocking of the temporary line to prevent any movement. *(See Fig. 2)*.



-Section-

Figure 3

By-Pass Main. In the event our survey disclosed a considerable number of joint or other leaks, in addition to a very bad crater, the situation would require a by-pass main for the whole section damaged.

In this case the existing main would be dug up at the nearest undamaged sections on both sides, and elbows, bends, tees and similar fittings would be used to bring up the main to the surface, where new sections of pipe would be placed, preferably at the curb so that traffic would not be obstructed. If necessary, the by-pass main could be of reduced size by using reducing fittings for the connections. Steel or any other type of pipe can be used for the by-pass main. *(See Fig. 3).*

Other Types of By-Pass Lines. In an area where terrain conditions require flexibility in portions of temporary by-pass mains, several lines of hose running side by side can be fed into a header connected to the other section of the temporary main. Arrangements of this type should be placed out of the way of traffic.

Disinfection of Lines. In any type of repairs there is need for safeguarding against contamination, and where sewage is involved special care must be taken to provide for larger amounts of chlorine to remove the dangers of sewage pollution. The taste and odor of the chlorine is of secondary importance in comparison with the need for complete sterilization.

Restoration of Service. In turning on gate valves the water should be allowed to enter the mains slowly and all of the air in the mains must be released through air vents, hydrants, or faucets to prevent unnecessary damage. The repaired sections are then inspected to determine whether there are any small leaks.

Conclusion. There is no emergency that cannot be met if proper materials, equipment and well trained men are available, and it should be recognized that a thorough familiarity with our individual distribution system is absolutely essential for the welfare of our community.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 7

To be reproduced locally for distribution to Class Members

Temporary Repairs to Broken Water Mains

Introduction. Prompt restoration of service is essential when emergencies occur, and it must be recognized that this result can be attained only through the medium of well-trained workers and adequate supplies of proper materials and equipment. Emergency repairs are usually made with mechanical fittings which require no poured joints. Although mechanical fittings are associated with temporary repairs, they can be and are in many cases as permanent as other types of fittings. Where circumstances permit, a preliminary survey of the extent and type of damage may save much valuable time which could be utilized in attending to other repairs during an emergency.

Preparation for Repairs. Preparation for repairs should be made with the following considerations in mind:

A Reporting of leaks through regularly organized channels.
B Investigating and detecting leaks through the use of instruments and adequate location records.
C Shutting down of gate valves.
D Provision of protection against hazards—barricades and safety lights, etc.
E Knowledge and familiarity with all types of materials for use in repair and related operations.
F Sufficient labor to execute repairs generally requiring about three laborers to one skilled worker.
G Arrangements in advance for necessary standard repair equipment.

Types of Break. The following are four types of break:

A Transverse break—break across main. Many can be expected in event of bombing attacks. Simple to repair.
B Longitudinal—break along main generally requires replacement of pipe.

C Major break—the most common type resulting from bombing. Generally involves several sections of pipe.

D Other types—pulling out of taps, blow-out of a section of pipe, punctures, bruises, etc.

Repair of Simple Breaks. The following are important considerations in the repair of simple breaks:

A Providing by-pass service or making repairs with reduced pressure in mains.

B Drilling and probing through pavement for the location of a break and permanent removal after location of break is determined.

C Avoidance of unnecessary excavation.

D Pumping for the purpose of dewatering excavation.

E Selection of proper fittings for the repair job.

F Restoration of service—sterilization, releasing of entrapped air through valve and hydrant manipulation, examination for leakage, tightening of bolts, opening of valves.

G Backfilling—provision of firm and even bearing for repaired pipe. Careful selection of material placed around pipe, mechanical tamping, temporary surfacing over excavated area.

Repair of Major Breaks. The procedure for the repair of major breaks is basically the same as for minor ones. The repairs themselves vary, of course, with the conditions. Simple by-pass service may be arranged through the use of a fire hose connected between hydrants located beyond the damaged area. Examination for fractures and joint leaks must be made for a considerable distance on each side of the break. Sewer and water lines should be plugged with wooden or cast iron disc plugs as soon as possible in order to prevent further flooding or contamination of excavation. Night repairs during war operations are not advisable. Makeshift repairs or arrangements of a temporary nature should not be considered unless conditions warrant it.

A Extensive bomb crater—When extensive bomb craters are encountered, involving damage to several sections of pipe, it might be necessary to locate the repaired section in a temporary position along one side of the slope of the crater until such time as effective backfill of the crater may be made and the pipe line replaced in its original position. The British have had considerable experience with this type of repair.

B In the event of multiple breaks or leaks in combination with a very bad bomb crater, a by-pass main for the whole damaged section would be necessary. In such a case the existing main would be dug up at the nearest undamaged sections on both sides. It might be necessary to use reduced sized pipe for the by-pass. Conditions of terrain sometimes require that the by-pass have the utmost of flexibility. In such cases parallel lines of hose can be fed into a header connected to the other section of the temporary main.

Conclusion. There is no emergency that cannot be met if proper materials, equipment and trained personnel are available, and it should be recognized that thorough familiarity with the individual distribution system is absolutely essential for the welfare of the community

CLASS LESSON NO. VIII

Use and Operation of Repair Equipment

SYLLABUS FOR CLASS TRAINING SESSION NO. 8

2 Hours

Subject. Use and operation of repair equipment.

Instructor. Each local water superintendent who maintains sufficient repair equipment should give this lesson separately to his own auxiliaries. Otherwise, the instruction should be given to a combined group, with some other superintendent who has various types of repair equipment serving as instructor.

Scope. *Two hours:* Under direction of the instructor give each student practice in the operation of all equipment, such as leak detectors, tapping machines, chain hoists, paving breakers, compressors, etc.

Prior to lesson No. 9 provide each foreman with a map of distributing system and accurate record of valve locations. (To be treated confidentially by foremen of repair crews.)

Prior to lesson No. 10 assign for reading by each supervisor of emergency water delivery service, or emergency pumping or chlorination plant operators, some article from water works literature relating to the precautions which should be taken in handling chlorine.

Reference Text for Lesson.

Of first importance during and following air raids is the maintenance of the water system of any city or community. Fires cannot be successfully coped with unless an adequate supply of water under substantial pressure is available. We know how important it is for the health and welfare of the community to have an adequate supply of potable water during peace time. It is just as important to maintain these standards during emergencies. For these reasons it is important that efficient repairs of leaks and breaks be made in water systems as soon as possible after damage from aerial bombs or other explosives occurs.

Water from a leak may or may not show on the surface of the ground. Even though it shows, it does not necessarily follow that the

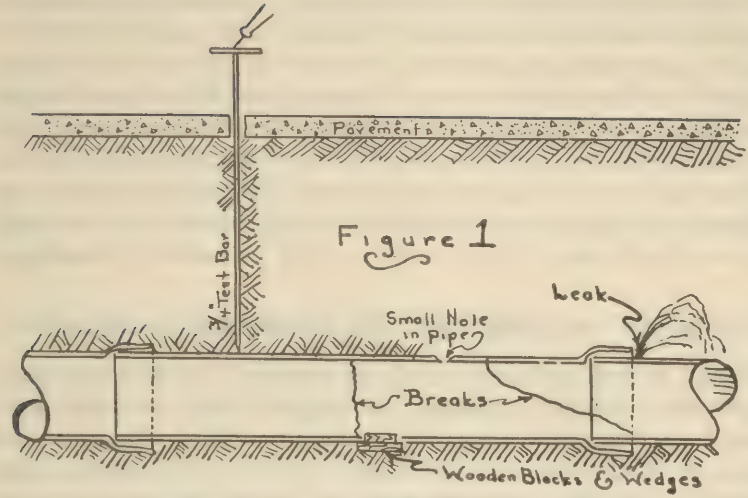
source of trouble is directly below the spot where the water appears. In this event, or in the event that no water appears on the surface at all, it is first necessary to locate the leak before repairs can be made.

One may well ask how it is known that a leak exists if there is no evidence of escaping water on the surface of the ground. Such knowledge may be acquired from an inspection of sewer or utility manholes where water may be found entering, or an indication of leakage may be given by the typical leak noise on hydrants, valves, or services to buildings. Hydrant inspections frequently give evidence of nearby leakage.

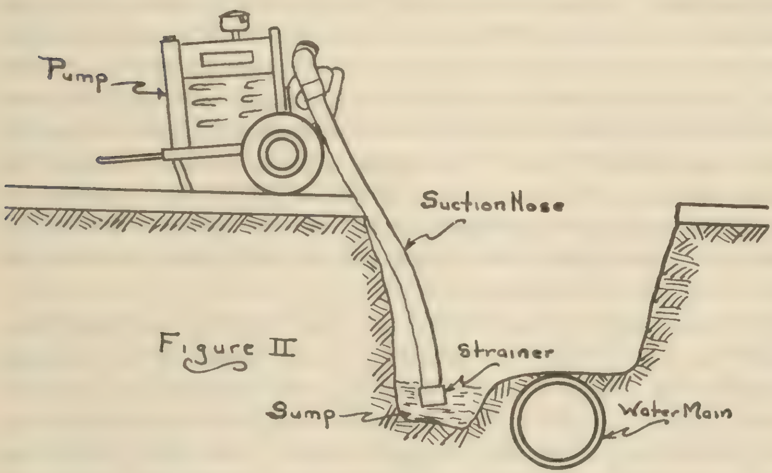
Methods for Locating Leaks.

There are several ways of locating leaks underground, and methods vary from one town to another. Some people use several different methods of locating leakage, depending upon the conditions. The simplest way of locating a leak, where expensive leak locators are not available, is to first listen on all hydrants, valves, services and any other physical connections to the mains in the vicinity of the leak by means of the "Aquaphone". For underground structures, such as valves, it is necessary to place a gate or curb key in direct contact with the valves or curb stops and to place the "Aquaphone" against this tool. A comparison of the intensity of the noise at various locations usually gives a general indication of the approximate location of the trouble. This routine may then be followed by the use of "Geophones" or electric leak locators, placing the transmitters of this type of equipment directly on the ground or pavement over the mains and again listening for the loudest noise. If the more expensive, so-called radio type, leak locators are available, the intensity of the noise may be read directly on the electric meter.

Equipment of the kind described above is not always available and is not always infallible. It is, therefore, deemed desirable by some water works maintenance men to drill a series of holes through the pavement and to drive test bars down through the soil, as shown in *Figure I,* to make direct contact with the water main. The test bar referred to is a piece of steel bar about ¾″ in diameter, pointed at one end and squared at the top so that a wrench or specially prepared handle can be applied to the bar for rotating it and lifting it after the test is made. This procedure serves two purposes. While listening on the bar with the "Aquaphone," or in some cases with a naked ear, a further check on the location of the leak may be obtained. Also, when the test hole is near the leak, water usually shows on the bar and the amount is a further indication of the nearness of the leak to the test hole.



Sketch Showing Test Bar, Leaks & Breaks



Sketch showing Pump & Sump

It should be pointed out that it is usually necessary to drive the test bar down through the soil with a sledge. Great care should be exercised as the point nears the main to see that it is not driven against the main with any great force, as in this manner it is relatively easy to crack the ordinary water pipe. In the event this precaution is not taken, you will certainly obtain a leak if you have not found the one you are already after.

Leak location is not a simple task and to become proficient at it requires considerable practice and training. For instance, due to the type of pavement, soil conditions, main construction, and proximity of public utilities and sewers, vibrations from leaks do not always readily travel to the surface of the ground, nor is the intensity of the vibrations heard in the "Aquaphone" a true indication of the distance of the leak from the point being tested. Moreover, leakage may appear in a manhole, or on the surface of the ground many feet away, or even blocks away from the point where the water is escaping.

Equipment and Methods for Breaking Pavement.

When the leak has been located, the next step is to break any pavement which exists in preparation for digging. In the old days pavements were broken by means of frost pins and sledge hammers, and, of course, this method can still be resorted to if air compressor equipment is not available. For emergency repairs to water mains, however, during or following air raids, air compressor equipment will usually be available. If there is an asphalt pavement at the scene of the leak, the paving breaker tool should first be fitted with an asphalt cutter, which is a tool made from a piece of steel approximately 4″ in width, ¼″ thick, sharpened at the end to a chisel edge. The asphalt should be cut through, first, with this tool in a rectangle about 6′ along the main and about 3′ wide. The asphalt can then be easily chipped out with the pneumatic tool starting at one corner of the rectangle and chipping out pieces approximately 12″ or 15″ square. The asphalt cutter is then replaced with a long pointed tool similar to a frost pin which is called a "breaking tool."

The next step is to cut the concrete base. This is most easily done with the tool by chipping out a hole in one corner of the rectangle, breaking off bits of concrete until a hole through the base has been made. Once an initial hole is made, the balance of the concrete breaks out much more easily and in larger chunks. The point of the tool should be driven into the concrete, by repeated blows, a distance of 3″ or 4″ and then pressure applied by the operator on the handles in a downward direction with the hammer still in operation. This tends to crack or chip off pieces of concrete which are 3″ or 4″ thick. This procedure, of course, depends somewhat on the character of the concrete and the absence or presence of reinforcement. If reinforcement is present, the quickest way to cut this is to excavate the concrete around it and to cut it with a hacksaw or with wire clippers if mesh has been used.

During winter weather difficulty may be experienced with the condensation of moisture in the air, which freezes up and causes the hammer to stick. It is well to heat the barrel of the hammer over a bit of waste which has been saturated with kerosene and ignited, before the hammer is put into operation. A little kerosene placed in the exhaust ports of the tool will also keep the tool free from binding due to frost. Care should be taken during frosty weather not to subject the point to too much prying action as the points are easily broken if full of frost.

Excavation and Pumping Equipment.

Digging a hole for a water leak is very much like digging any other kind of a hole, except that water is usually encountered before the main is reached. When water is found, a sump or pit should be dug in one corner of the excavation and the suction hose of a pump placed in it, as shown in *Figure II,* to keep the hole unwatered for further excavation. Excavation is then made away from the sump and, when the other side of the hole is level with the sump, a new sump is excavated and the procedure is the same as before. Simple as this procedure may seem, in the interests of time it is highly advisable to make an adequate sump hole and to see that the strainer on the end of the hose is kept as free from mud and debris as possible. Sometimes it is necessary to sink a pail perforated with holes in order to keep fine material from clogging the openings in the strainer.

There are several types of pumps on the market for unwatering excavations of this kind. Many people still prefer some type of diaphragm pump for leakage work, the reason for this being that if the diaphragm is in good condition one is always assured of a good suction lift and of keeping the prime in the pump regardless of the amount of water in the excavation. Three inch hose, 15′ to 20′ long, usually is the most convenient suction hose for this work. If motor-driven equipment is not available, the hand diaphragm pump is equally effective, providing plenty of help is available. Moreover, it has the decided advantage of simplicity, with but few parts to get out of order. Diaphragm pumps may be used for suction lifts of at least as much as 18′ and if the equipment is in excellent condition, they may be used for considerably greater lifts.

Much of the modern pumping equipment is of the self-priming centrifugal type. It is especially essential on equipment of this kind that there be no air leaks in the hose or its connections. Nothing is more annoying on a leak job than to be bothered with loss of prime, whether

the pump be diaphragm, centrifugal, or otherwise. It pays to take plenty of time to see that couplings on the hose are properly fitted to the nipples without cross-threading or otherwise damaging the threads and that the gaskets in the suction hose couplings are in good condition and are properly fitted. A relatively small air leak will defeat the whole purpose of the pump, especially on high lifts.

Centrifugal pumps which are not self-priming are of little value on a leak job even though fitted with foot valves, as once the prime has been lost a great deal of time is required to fill the hose and pump again after part of the water has been thrown out by the pump and has been replaced by air. This will happen every time the hole is unwatered by the pump gaining on the leak, unless a very careful adjustment of the valve is made on the discharge side of the pump. Care should be taken in winter weather to drain such parts of the pumps as retain water.

Some Necessary Precautions.

Great care should be taken in excavating for leaks to see that substructures, such as telephone and lighting ducts, gas mains and other substructures, are not damaged by the use of test bars, picks and paving breakers. The location of all such substructures should be ascertained before excavation is begun, and if they are located in the hole being dug, care should be taken to dig around them by hand.

As the average depth of cover on water mains is from 4′ to 5′, it is unusual that sheeting is needed. However, care must be taken to

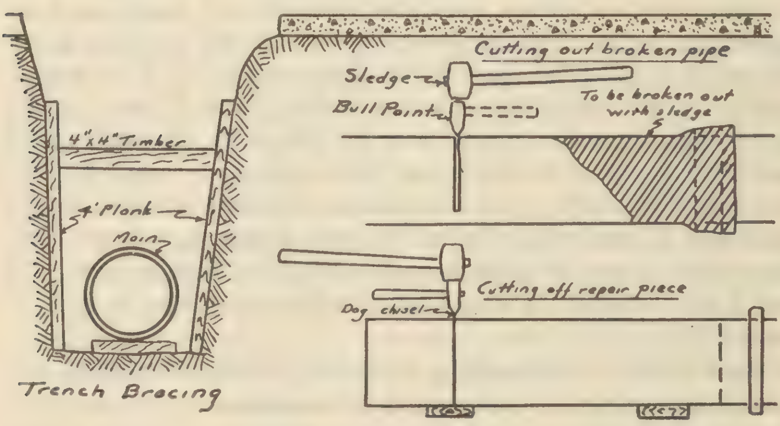


Figure III

protect the workmen in the hole where the excavation is deep or where material excavated is such that it tends to cave in or to slough off. This is particularly true where it becomes necessary to undercut the top edge of the hole in an effort to reach the source of trouble, which may not be centered in the hole dug. If sloughing or caving is encountered, it can usually be adequately cared for by placing short lengths of plank on end in the excavation and bracing them in place with a screw brace or 4″ by 4″ timbers cut to suitable lengths, as shown in *Figure III*. If it is necessary to make trench bracing or sheeting continuous, horizontal timbers 4″ by 4″ or larger, depending on the depth of trench, should be placed horizontally at the level where the trench bracing is used in order to support all of the sheeting. In some cases, it may be necessary to do the same near the bottom of the trench. All cross bracing should be placed between the horizontal timbers when the latter are used.

Repair of Joint Leaks.

After the leak is excavated, if a joint leak, it can be repaired by one of the following methods:

1 Lead joints—recalking or repouring and calking.
2 Joints made with compound—cut out leaking portion and calk with shredded lead.
3 Universal pipe joints—loosen bolts, re-align pipe, block in place and tighten bolts.
4 Flanged pipe—usually due to rubber or paper gaskets being blown, necessitating the removal of the bolts and renewal of the gasket. This usually involves removing a lead joint at some nearby location to obtain sufficient flexibility to renew the gasket.

If much of the lead joint is blown out, it will probably be necessary to close the valves on each side of the leak and to make a complete shut-off and to repour the joint. The technique of making and calking lead joints will be taken up under repair of main breaks.

Where a small amount of the joint material is missing, it can frequently be repaired by calking it with shredded lead. This is lead prepared in fine shreds, sometimes called "lead wool," which can readily be driven in where needed and calked with the proper tools in much the same manner as with a solid lead joint. If the leak is not too large, recalking a lead joint which has loosened up or repairing it with shredded lead can usually be done without shutting off the

water. It is frequently desirable to cover the leak with a raincoat or blanket, to confine the escaping water so that the calker may work in greater comfort. The initial calking can then be done underneath the covering and as soon as the flow of water has been restricted, the covering may be removed and the final calking done with maximum convenience.

On pipe under high pressure where a joint leak is encountered it is sometimes necessary to use a "lead Dutchman," made by flattening a piece of lead tubing and drive this into the leak before recalking the joint. Any lead calking which is necessary should be done in the manner hereinafter described.

On a joint under a railroad track or in other restricted places where it is difficult to recalk, or in the case of some joints where there is a considerable deflection in the pipe and it is not practical to obtain a good joint by the usual method, the use of bell clamps is recommended. These have been described in other lessons. Their installation is a relatively simple matter. It is only necessary to see that the rubber gasket is fitted snugly up against the joint and that the bolts which hold the follower piece against the gasket are drawn up with even tension all around the joint. It is frequently desirable, also, to use these clamps on straight work where it is not practical to shut down the main or where time in making repairs is an element, as may frequently be the case during air raids.

Backfilling the Excavation.

Before backfilling the excavation, all wet material should be removed and selected back fill used, particularly if trench settlement must be avoided. Run-of-bank gravel is satisfactory for this work, providing it is not too coarse. Ashes or cinders should never be used around the pipe. Backfill material should be tamped in layers of approximately 6″ with hand tampers or compressed air tampers if available.

Repair of Cracked, Split or Broken Pipes.

It is usually unnecessary to test for breaks, as these generally show on the surface. After gate valves have been closed to isolate the main to be repaired, the same methods of pavement breaking and excavating are used for break repair as for leak repair, including the use of pumps. After the excavation is made to find the location of the break, it is sometimes found that these breaks consist of cracks all the way around the pipe, a split pipe or a piece broken out. If the pipe has a piece broken out or if it is split over 6″, it is necessary to cut out and sleeve-in a piece (*See Figure IV*) using a solid sleeve and a bell piece or a spigot piece of pipe, whichever the condition requires.

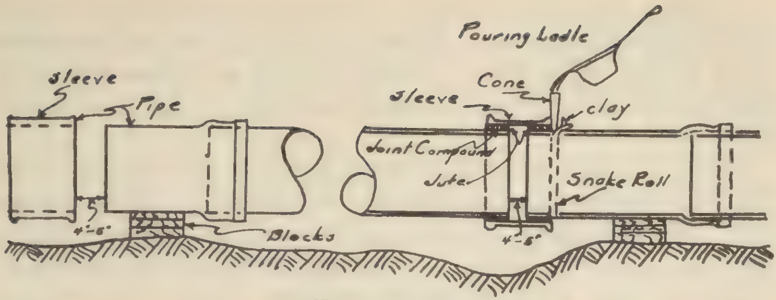


Figure IV

Sketch Showing Use of Solid Sleeves & Pouring of Joints

The procedure to be used in making repairs for breaks for the type of break described above is as follows: If the break occurs within a few feet of a joint, a "V" notch is cut about three-fourths of the way around the pipe on the opposite side of the break from the joint, using a "diamond point" chisel on small mains from 4″ to 12″; on larger mains, 12″ up, a tool called a "bull point" is used for cutting the "V". *(See Figure III.)* A diamond point is a chisel with a diamond shaped point which is struck with a calking hammer or other hammer weighing about 4 to 6 lbs., and a bull point is a chisel similar in shape with a hammer head and handle. One man holds the bull point in proper position by means of the handle and another strikes the hammer head with a sledge. With either equipment, the object is to cut small pieces of cast iron out with each blow to form a "V" in the pipe. Care should be taken to avoid flying bits of cast iron, as these frequently get into workmen's eyes.

After these cuts are made, a tool called a "dog chisel" is used to break a small hole through the "V"-shaped cut at the top of the pipe. A dog chisel is a hammer-like tool with a chisel point. It is used in much the same manner as that described for the use of the bull point, one man holding the handle and another man striking with a sledge. A "splitting chisel" is next inserted in the hole which has been broken through the pipe wall . This is a long tapered chisel that is driven into the top of the pipe through the above-mentioned hole and when driven in as a wedge causes an even crack all around the pipe at the location of the "V". Before the pipe will crack as desired, it is usually necessary to break out the piece of pipe between the break and the

joint with a sledge. This allows movement in the free end of the pipe when the splitting chisel is driven in and facilitates the final cutting off of the pipe where the "V" has been made, as in *Figure III*. The depth of the "V" should be about three-fourths of the wall thickness of the pipe.

Usually on pipe larger than 12″ in size, it is necessary to use the dog chisel around the pipe at the bottom of the "V" which has been cut. This will cause a crack to form through the remaining wall of the pipe. Splitting chisels are used as described above, and on the larger pipe sizes, it will probably be necessary to use two on the upper quarters of the pipe.

In cutting the new piece of pipe for the repair, allowance should be made for the depth of bell if necessary. This means that the length of pipe should be, usually, from 4″ to 5″ shorter than the total distance from the botom of the bell to the end of the pipe which has been cut off in the trench. *(See Figure III.)* To make this cut on the surface of the ground, the length of pipe from which the piece is to be cut should be supported on plank or blocks, one support being immediately back of the point at which the pipe is to be cut. For pipe having wall thicknesses greater than about ¾″, it is necessary to cut a "V" entirely around the pipe in the same manner described above for cutting pipe in the trench. The dog chisel is next used at the bottom of the "V" continuing the cut around the pipe until the piece cracks off. For pipe with wall thicknesses less than ¾″, the cut can be made by use of the dog chisel alone. *(See Figure III.)*

Repairing Breaks in Middle of Pipe Length.

If the break is in the middle of a length of pipe, it may be undesirable to break out a half length in order to reach a joint. In this event, it will be necessary to make two cuts as described above, one on each side of the broken piece of main. This is more difficult and requires care in guarding against breaking or splitting the pipe back through the "V" cuts which have been made. In repairing this type of break, if time is an element, it is better to break out the pipe with a sledge and to cut off the jagged ends afterwards by the methods described above.

The next procedure is to install the new piece in place and prepare to run the joints which are necessary.

In the case of small sizes of pipes and fittings, no special problems are presented in the lowering of these materials into the trench. If the pieces to be handled are heavier than can be passed from one man to

another, a piece of rope is commonly used to lower the pipe or special into the trench, skidding it over the edge of the bank or down a piece of inclined plank. In the case of a length of pipe, two-rope slings are usually used, one end of the sling being held at the top of the trench and the other side of the sling allowed to pay out as the pipe rolls over the edge of the trench to the bottom of the same. For heavier material, "A" frames or any type of stiff leg tripod can be used from which is suspended an ordinary chain fall of adequate capacity. The pipe or fitting is rolled or skidded on timbers laid across the trench under the chain fall, is picked up by the fall and when the timbers are removed is lowered into place. For still heavier material, the use of power cranes is recommended.

The standard method of making repairs of this kind is to use a solid sleeve which is a cylinder of cast iron with ends grooved as in the bell of a pipe and the diameter of which is the same as pipe bells for the same class. Careful measurements should be taken of the external diameter of the pipe to be repaired if the class is not known, and a sleeve selected the internal diameter of which will provide for a joint not less than ⅜″ and not more than ¾″ in thickness. The ideal thickness of a joint is from ½″ to ⅝″. The sleeve is placed on the end of the pipe which has been cut off in the ground and slid back until the outer end is flush with the pipe. The new piece of pipe which has been prepared is then inserted in the bell of the other length if one is available, or if the end of the pipe is a spigot, the new piece of pipe will be a bell piece. In any event, the new piece is properly fitted to the undamaged pipe which is exposed in the excavation and is blocked up in position to line up with the old pipe, using lengths of plank or 1″ pieces where needed. These should be about 8″ in width and 12″ to 14″ in length. The solid sleeve is then pulled along the pipe to cover the 4″ or 5″ opening where one is necessary, and is centered on this opening. Care should be taken to see that the interior of the sleeve and bell and the exterior surfaces of all pipe are wiped clean and dry. It will be difficult to obtain good joints if water is present. In the event that the valves which were used to make this shut-off are leaking, it may be necessary to put small clay dams in the pipe to hold back the water while the joint is being made. Only clean, unpolluted material should be used for this purpose.

Method of Sealing New Joint.

The next step is to insert either soft or braided jute into all joints and to drive the same back about 3″ in such a manner that it is tight and forms a dam to hold the joint material from flowing into the pipe

when the joint is formed. This jute also acts as a spacer to obtain the uniform thickness of joint. Special chisels called "yarning irons" are used for this purpose. Where braided jute is used, one strand is usually enough, although many water works foremen use two. The purpose of the jute, as stated above, is to center the pipe and to form a dam to retain the joint material. Jute should be lapped 3″ or 4″. Care should be taken in the case of a sleeve to see that the jute is not driven back too far where it will drop into the open space between the ends of the pipe. In this connection it is important to use sufficient soft yarn to form a tight wedge, or square jute which is of proper size.

The next step is to place a "snake roll" around the pipe, tight against the bell or sleeve where the joint is to be made. These rolls are specially made for this purpose and presumably have been described in other lessons on equipment. The roll should be moistened, placed around the pipe and the two ends clamped together at the top with a "C" clamp with the ends bent down horizontally against the pipe.

A pouring gate should be made of moist clay to form a funnel where the ends of the "snake" meet if lead is to be used, and if joint compound is to be used, a special funnel for this purpose should be inserted and sealed in place with clay. Also, where lead is used the "snake" should be covered all around the joint with a liberal application of damp clay. The "snake" forms a dam on the outside of the joint to hold the joint material in place as the jute does on the inside.

Whether lead or joint compound is used, it is melted in melting pots or kettles, usually over kerosene or gasoline heating equipment which operate under pressure. It can be melted over a wood fire, but the use of pressure fuel equipment is recommended where available. Lead should be heated until thoroughly melted and joint compounds should be heated until a glassy, mirrorlike surface is obtained on the material. Care should be taken not to overheat joint compounds with too hot a fire. Should the material become too hot and have a grainy appearance, the fire should be lowered or shut off and the material allowed to cool until the glassy, mirror-like surface is obtained. Joint compound which is being overheated will give off excessive sulphur fumes. In this event the material may become burned and joints made from it will be soft and ineffective.

Care in Handling Hot Lead or Compounds.

Great care should be taken in carrying lead or joint compounds from the kettle to the point where the material is to be used. Accidents may easily happen in passing this material from man to man, especially

in wet or slippery trenches. It pays to provide safe and adequate means of carrying this hot material, especially lead, from the kettles to the joint. Either lead or joint material should be poured slowly into the gate or funnel, so that the air may come back from the joint without bubbling or forming pockets. If more than one ladle is required, the second ladle should be available as soon as possible after the first one, so that joints will not be formed in the joint material in the joint itself. The joint material should be poured into the joint until an excess of approximately two-thirds the height of the funnel or gate is reached.

Calking Lead Joints.

Where joint material is used no calking is required, and the joint may be put into service as soon as the material has solidified. For this and other reasons it is recommended that joint material be used by men of limited experience in preference to lead, especially where time is an element. If lead is used, however, it must be thoroughly and properly calked or up set in the joint, in order to make the joint tight. This is done with the use of calking tools, which are tools similar to chisels, with offsets which allow the points to be placed against the joint and the handle to remain an inch or two above the barrel of the pipe, where it may be easily struck with the calking hammer. The tools are numbered, the higher the number the wider the tool. The first step in calking a lead joint is to use a chisel to drive the lead back to form a "V" next to the barrel of the pipe. The No. 1 Tool is then used, which has a blunt point but is relatively thin. The lead is driven back all around the joint, keeping the tool next to the barrel of the pipe. Other tools of varying thicknesses, up to one which will cover the entire thickness of the joint, are subsequently used, each one driving back and up, setting an increasing width in the lead joint. Calking is a hard and tedious process and the tendency is to calk the upper part of the joint, which is easily reached, in a workmanlike manner and to neglect the underside of the pipe, where it is more difficult to reach the joint. For this reason plenty of space should be excavated around the joint to allow the worker maximum convenience. Tools are available for use in pneumatic calking hammers. If this equipment is used, care should be taken not to drive the lead too tightly into the bells, as it is possible to crack the bell in this manner. *(See Figure IV.)*

Where a break in Universal pipe is encountered, such as the bolt ears, it is necessary to cut out and sleeve-in a new piece of pipe similar to a bell and spigot pipe repair job.

Where the break or leak consists only of a hole in the pipe less than 2″ in diameter, a tapping machine may be used to drill a threaded hole in the pipe into which a brass plug or corporation cock may be screwed. If a length of pipe has a split in it about 6″, or if it has a crack running around the pipe, or if a pipe has been broken off completely, the simplest and quickest way of making a repair is by the use of one of the several split sleeves or couplings which utilize rubber gaskets. Their use is relatively simple and requires little explanation. The rubber gaskets or lengths which are provided with a lap are installed around the pipe each side of the fracture and so spaced that they will fit into recesses provided for them in the sleeve casting. The lower half of the casting is held up in place and the top half bolted to it. The split lengths or followers which are provided with this equipment are next assembled at each end of the sleeve, bolted together, and then bolted to the sleeve proper. The latter bolts should be drawn up evenly all around, so as to wedge the rubber gaskets firmly against the wall of the pipe in the recesses in the sleeve. This forms a water-tight and flexible joint in the pipe. Care, of course, should be taken to see that proper sized sleeves are available to fit the pipe in question.

Use of the Tapping Machine.

Installation of new pipe to repair breaks sometimes necessitates providing new taps for services to buildings. This is done with a tapping machine which may be used on pipe whether under pressure or dry. In most cases it is used when there is pressure in the pipe. This lesson will describe the use of a Mueller tapping machine.

A saddle should be selected which will fit the pipe to be tapped. Pipe should be carefully cleaned at the point where the tap is to be made, so that the rubber gasket underneath the saddle will make a water-tight joint with the surface of the pipe. The machine is secured to the pipe by means of the chain provided for this purpose. The nuts on the bolts which tighten the chain should be tightened so that the machine is relatively rigid. After the machine is properly secured to the pipe (it is usually placed at an angle of 45 degrees with the vertical axis of the pipe) a tap of the proper size for the corporation cock which is to be used is secured in the chuck on the end of the shaft and the shaft assembly is screwed in the top of the machine. The shaft is then pushed down until the tap makes contact with the surface of the main and the yoke brought into position. The check valve, of course, is in the wide open position. The hole is drilled in the pipe by means of the ratchet handle on the outer end of the shaft,

pressure on the tap being applied by means of turning the yoke above referred to in a clockwise direction, just enough pressure being applied to make the tap cut smoothly and uniformly. As soon as the tap breaks through the inner wall of the pipe, the tapping machine will be filled with water.

As soon as the tap has gone through the wall of the pipe, the same operation is continued of rotating the shaft and applying slight pressure on the collar until the threaded portion of the tap is engaged in the wall of the pipe. The tap will then, of course, feed itself, rotation of the shaft only being necessary. A little practice will be needed to know just how deep to cut the threads to fit the standard corporation. When sufficient threads have been cut, the rotation of the shaft is reversed and the tap unscrewed from the wall of the pipe and pulled back as far as it will go. If there is much pressure in the pipe it will come back by itself and it may be necessary to control its movement.

The next step is to shut the check valve by means of the knob on the outside of the tapping machine, release the water pressure in the top of the machine and remove the shaft assembly from the machine body. The lower part of the machine is now under pressure from the main, whereas the upper part is under no pressure. The tap is now removed from the chuck and a screw plug inserted. This is a piece of equipment with a shank the same shape as the upper part of the tap and the lower part tapped out to fit the outside threads on the upper part of the corporation, or provided with a threaded shank which will fit the inside threads of the upper part of the corporation. The corporation is then screwed onto this plug and the shaft assembly replaced on the top of the tapping machine. Water is then admitted to the upper part of the machine and when the pressure is balanced, the check valve opened again. By pushing down on the shaft, the corporation will enter the threaded hole which has been made in the pipe wall and the corporation can be screwed into it by rotating the shaft in a clockwise direction. Corporations should be screwed in rather tightly, but should not be unduly forced. To disconnect the shaft and screw plug from the corporation, the shaft is rotated in the counterclockwise direction with a sudden movement which will cause it to unscrew from the corporation, rather than the corporation from the pipe. The shaft is withdrawn and the machine may now be removed from the pipe, as the corporation has sealed off the pressure from the inside of the pipe. It is obvious, of course, that corporations should always be closed when inserted in the pipe.

Service Leaks.

Service leaks usually necessitate repair by a plumber. These services are either lead, copper, steel or wrought iron pipe. Lead services are usually repaired by cutting out the section which has failed and installing a new piece with wiped joints. This requires the services of a plumber. Copper services may be repaired by cutting out, with a hacksaw, the section which has failed, flanging the ends with a sledging tool and cutting and flanging a new replacement piece. The new section may then be installed by using copper service pipe couplings. Small leaks in steel or wrought iron pipe may sometimes be repaired with split sleeves similar to those used on larger cast iron pipe. Should the leakage extend 3″ or 4″, it will be necessary to cut out the section of pipe, thread the remaining ends and install a threaded nipple with unions.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Ountline for Lesson No. 8

To be reproduced locally for distribution to Class Members

Use and Operation of Repair Equipment

It is not necessarily true that a leak may be found directly below the spot where water appears on the surface. Knowledge of a leak may be gained as follows:

1 Inspection of sewer or utility manholes.
2 Detection of typical leak noise at hydrants, valves, or services in buildings.
3 Hydrant inspections.

Leaks may be located with the "Aquaphone" by listening at hydrants, valves, services and other physical connections to mains. For underground structures, such as valves, it is necessary to place a gate or curb key in direct contact with the valves or curb stops and then to place the "Aquaphone" against this tool. Following this procedure, the "Geophone" or electric leak locator, may be brought into use.

This type of leak-locator equipment is not always available. Also, it is not infallible. In either event it is deemed desirable by many waterworks men to drill a series of holes through the pavement and to drive test bars down through the soil, making direct contact with the water main. Precautions should be taken that the test bar is not driven against the main with great force.

Leak location offers the following difficulties:

1 The sound from leaks does not always travel readily to the surface of the ground.
2 The intensity of vibration heard in the "Aquaphone" is not necessarily a true indication of the distance to the leak.
3 Indications of a leak may appear in a manhole or on the surface of the ground many feet or even blocks away from the point at which water is escaping.

Once the leak has been located, the next step is to break through any pavement preparatory to excavating. Air compressor equipment,

with suitable accessories for cutting through all types of pavement, is the most efficient for emergency purpose. There are certain practices useful to know in the handling of air compressor equipment and accessories during winter weather.

A sump or pit should be dug in one corner of an excavation. A suction hose with a strainer should be placed into the sump for unwater-purposes. This suction hose is, of course, attached to a pump which may be one of several types. The distance water is to be lifted may determine the type employed. Maintaining the prime in a pump is of utmost importance.

In excavating, special precautions should be taken that substructures, such as telephone and power ducts, gas mains and others, are not damaged. The location of such substructures should be ascertained before excavation begins. Sheeting may be necessary when the material being excavated sloughs off or when it becomes necessary to undercut the top of the hole.

Joint leaks can be repaired by one of the following methods:

1 Lead joints—recalking or repairing and calking.
2 Joints made with compound—cut out leaking portion and calk with shredded lead.
3 Universal pipe joints—loosen bolts, re-align pipe, block into position and tighten bolts.
4 Flanged pipe—the usual cause here is the blowing out of a gasket. Repair in this case usually involves removing a lead joint at some nearby location to obtain sufficient flexibility for renewal of the gasket.

If only a small amount of the joint material is missing, the repairs can be made by calking with shredded lead, known as lead wool. And when the leak is not too large, the recalking may be done without shutting off the water. A "lead Dutchman" is sometimes used on a pipe under high pressure. This is made by flattening a piece of lead tubing and driving it into the leak before recalking.

Joints located under a railroad track and in other restricted places are difficult to recalk. In such instances bell clamps are recommended for repair. The bell clamp is recommended, too, when there is a great deflection in the pipe, when it is impractical to shut down the main, and when time is the chief consideration as is the case during air raids.

The general procedure in pavement breaking and excavating for leak repair applies also to breaks. When cutting is necessary for the repair of a break in a cast iron main, some or all of the follow-

ing tools may be used: diamond point chisel, bull point chisel, dog chisel and splitting chisel. The application of these tools varies with the diameter and the thickness of the walls of the pipe.

Exterior surfaces of all pipe which is to be joined by sleeves should be wiped clean and dry. Good joints are difficult to obtain when water is present. Clean and unpolluted clay should be used to dam back the water in a main under repair in the event that shut-off valves are leaking. Jute is then driven into the joint to center the pipe and to hold the joint material from flowing into the pipe. The next step is to place a "snake roll" around the pipe. This device forms a dam on the outside of the joint to hold the joint material in place. A pouring gate or a special funnel are aids used in pouring joint material.

When lead is used for joints, it should be thoroughly melted. Joint compounds should be heated until they take on a glassy, mirrorlike surface. When joint compound is overheated and burned, the joint is rendered soft and ineffective. Compounds require no calking. Lead, however, must be thoroughly and properly calked for a tight joint. Special calking tools, numbered in the order in which they are used, are employed for this purpose.

Sometimes the repair of a break necessitates the installation of new taps for services to buildings. The taps are made with the aid of a tapping machine, as is also the installation of a corporation cock. Service leaks usually are repaired by a plumber.

CLASS LESSON NO. IX

Operation and Care of Valves and Hydrants

SYLLABUS FOR CLASS TRAINING SESSION NO. 9

2 Hours

Subject. Location and operation of valves and fire hydrants.

Instructor. Each local water department head should give this lesson separately to his own foremen.

Scope. *First hour:* Explanation of the location and characteristics of all valves and hydrants over the system. Explanation of the operation and manipulation of a valve and fire hydrant.

Second hour: Demonstration of the flushing of a fire hydrant, the opening and closing of valves, etc. Illustrate by charts or diagrams the effect of water hammer. Discussion and oral quiz.

Reference Text for Lesson.

Valves are an absolute necessity in any water system, but in many cases are one of the most neglected items. Buried out of sight and forgotten until some emergency arises they are then expected to perform their appointed duties without delay or difficulty. Too many water departments have no systematic plan of inspection or maintenance but trust that providence will be kind at the appointed hour. Valves used in water works systems are all of the type known as gate valves, except for a few special applications, and provide a straight through passage way for the flow.

Two Styles of Water Valves.

Details of the construction of the gate mechanism differ with the several makes, but the basic principle remains the same. One great difference between water works valves and those found in industry is that they may be and are built in two styles as regards operation; that is, they may require turning to the right or clockwise to close, or the opposite. To get this clear in your mind, lay your watch face up in front of you and if the valve turns in the same direction to close as the hands of the watch it is a right hand valve. Almost all industrial valves are of this type, but many water departments use the left hand

valve exclusively and some have both kinds in the same system. I do not know why the left hand valve was built in the first place, but it was and is, so we have to contend with it. There is no way of telling by inspection, with the valve six feet underground, as to which type it may be and thus we come back to the importance of having complete records of all underground construction. You do not need a long piece of pipe for a lever or four men on a key to turn an 8 inch valve, but which way you should turn it can be learned only by study with members of your local department.

Care in Operating Valves.

Valves should be operated slowly, either in opening or closing. You men are in training for emergencies and that means that your work on valves, etc., will take place when something serious has happened. Pipes will be broken and the flow of water must be stopped, not alone to prevent damage to adjacent property and possible drowning of persons caught in cellars, but to conserve the supply and maintain adequate pressure for fire protection. So I repeat that valves must be operated slowly. Water is in some respects a solid non-compressible substance. When you consider that you may have many tons of it moving at a velocity of several feet a second and attempt to stop that movement instantly, by the sudden closing of a valve, you get all the effects of a heavily laden truck hitting a concrete wall. Something must give—and in this case it will be a water main. If you have had a bombing raid there will have been sufficient destruction without adding to it by carelessness.

All valves should be accurately located and shown on suitable sketches or blue-prints, bound in pocket-size note books. Measurements should be taken from easily found points, such as curb lines or building foundations, never using trees or fences, which may be removed before you have a chance to use them.

Hydrants and Their Maintenance.

Hydrants are very similar to valves, in that they require inspection and care and receive about the same amount of neglect. In fact, a hydrant is a valve, built into a vertical pipe having suitable connections for fire department use. While hydrants are built both right and left handed, as was mentioned regarding valves, they have this important advantage, that the direction in which the valve must be turned to open is always plainly marked with an arrow on the top of cover. The same rule regarding the use of undue force in operating applies

to hydrants as well as to valves. If more than one man on an 18 inch wrench does not get results, either you or the hydrant are out of order. Caps should be greased with a water-resisting grease, to prevent rusting of the threads in the cast iron caps and the leather packing should be kept in good condition. The stem should be packed with suitable packing, one that does not dry out or corrode the parts, but nevertheless remains tight when the hydrant is in use. No fireman wants a shower bath when using a hydrant, and it is unnecessary with proper maintenance.

One feature of hydrant maintenance that requires mention is that of unauthorized use. It is very rare that a valve is ever disturbed, as special tools are required to operate it; but hydrants seem to be fair game for everyone who owns a Stillson wrench and wants to mix a bit of concrete or even wash a car. If you are so unfortunate as to live in a community where such doings are common practice, only constant inspection will keep your hydrants in working order. Such practices are unnecessary, as public education coupled with a trip to police court for some of the most obnoxious offenders will work wonders. Another feature of hydrant maintenance that should not be forgotten is that of freezing in winter. All hydrants are provided with an automatic drip which opens when the hydrant is shut down and drains the water out of the barrel. If drip mechanism is in working condition there will be no water in the hydrant to freeze. There may be a few local exceptions to this statement, where the ground water level is so high or soil conditions such as to prevent the water from running out. In these cases a liberal dose of denatured alcohol will prevent trouble.

Certain features of valve and hydrant repair have been and will be touched upon in a lecture on Emergency Repairs connected with this course.

There are so many different makes and styles of valves and hydrants that it is impossible to do more than give a general resume. The person giving the lecture to the local foreman should include the details about the valves found in his community.

CLASS LESSON NO. X

Operation of Chlorinators and Handling of Chlorine

SYLLABUS FOR CLASS TRAINING SESSION NO. 10

2 Hours

Subject. Operation of chlorinators and handling of chlorine.

Instructor. Instruction preferably should be given to a combined group of auxiliaries from all towns and villages of the county. An outstanding water superintendent or representative of a chlorination equipment manufacturer should serve as instructor.

Scope. *First hour:* Lecture on care and operation of various types of equipment, various types of installations, precautions in handling chlorine, storage of cylinders, and related matters. Use actual equipment or diagram to illustrate apparatus.

Second hour: Demonstration of the disassembly, cleaning and reassembly of a chlorinator, method of connecting a chlorine cylinder, and use of gas mask.

Assign for reading prior to lesson No. 11 some articles from water works literature or water works text book which explains the operation of various types of pumps.

Reference Text for Lesson.

The purpose of this lecture is to instruct water works auxiliary operators in the methods of handling chlorine, the installation and use of chlorinators, temporary methods of treatment and the steps to be taken in the event of an emergency.

First, if normal service is interrupted by bombing or sabotage, all persons should be instructed to boil ALL water used for drinking. It it assumed that immediate steps will be taken to repair damages to water mains and that these mains will be given proper sterilization before being returned to service. It may be necessary to place emergency pumps in service, such as fire engines or portable gasoline driven pumps. The use of chlorinators to meet these conditions will be described in detail later.

The first step after organizing a class for auxiliary operators is to thoroughly instruct them in the fundamentals of operation of any existing chlorinating equipment which may be in use on your water

supply or available for emergency use from nearby swimming pools, sewage or industrial plants. There are so many different types of chlorinators in operation throughout the country that it is impossible here to go into a detailed description of the various units. It is assumed that each operator is familiar with the operation of the particular type of chlorinator installed in his plant. All auxiliary operators should be instructed in the care and operation of these machines as it is more than likely that existing chlorinators may be moved for use at the point of emergency treatment.

In emergency treatment, as in normal operation, an accurate method of application is necessary because chlorine in any of its forms is a very powerful sterilizing agent. Therefore, extremely small quantities must be controlled within narrow limits for even fairly large volumes of water. For example: 500 gals. per minute equals 720,000 gals. per day. Normal chlorination would be at an average rate of about 0.5 p.p.m. This would be at the rate of approximately 0.03 ozs. per minute or a total of 3 lbs. of chlorine in 24 hours. Emergency treatment might be as high as 5 p.p.m. or 0.3 ozs. per minute or 30 lbs. of chlorine per day. Sterilization of mains which have been repaired or replaced would be at a much higher dose—from 50 to several hundred parts per million, depending on conditions and local standards or requirements. *(See technical publication No. 408.)*

Chlorine and How to Handle.

Chlorine gas is obtained commercially by passing an electric current through a solution of common table salt. The gas is collected and compressed or "liquefied" and stored in steel cylinders under pressure. Chlorine gas—so-called—is shipped in steel cylinders, having net contents of 8, 16, 100 and 150 lbs.

The condition of chlorine in the cylinder can best be compared to water in a steam boiler. When a valve leading from a boiler is opened, steam flows; and as this steam flows away, it is replaced in the boiler by further evaporation from the surface of the water in the boiler. The evaporation is accomplished by means of heat under the boiler. The pressure in the steam boiler depends on the temperature and not on the amount of water present in the boiler. Conditions in the chlorine cylinder are exactly the same.

When the chlorine cylinder valve is opened, the gaseous chlorine present flows from the cylinder and is in turn replaced by gas evaporated from the surface of the liquid chlorine in the cylinder. In this instance, however, the heat necessary to evaporate the chlorine gas

is drawn from the atmosphere surrounding the cylinder. This is true because the amount of heat necessary to evaporate chlorine gas is considerably less than that necessary to evaporate water. For this reason, for ordinary use, it is not necessary to apply heat to accomplish this evaporation. However, if it is desired to draw gas from an ordinary cylinder at a rate in excess of 40 to 50 lbs. per day, it is necessary to add heat. In ordinary sanitary practice, this is not necessary, as one cylinder of chlorine will evaporate 40 to 50 lbs. of chlorine per day.

In large cities where greater amounts are desired, the same results are accomplished by hooking up the cylinders in multiple units. For example, in operating at the rate of 400 lbs. per day, it is customary to connect up a battery of 10 cylinders, which can then easily draw the necessary heat of evaporation from the surrounding atmosphere.

Some Properties of Chlorine.

Chlorine gas is non-explosive and non-poisonous. Those of you who have used chlorine in the treatment of water or sewage know that it can be handled with complete safety. Fortunately, chlorine gas has a very distinctive odor. It is unmistakable even when minute quantities are present in the air. All of you are familiar with this chlorine odor. Your wives probably use some chlorine bleach water in the washing machine to make the white clothes whiter. Dairies use large quantities of chlorine water or powder to keep pipe lines, vats and floors clean and sterile. Ordinary chloride of lime, as used in every respectable outhouse, familiarizes all of you with the odor of chlorine. Chlorine is an irritant and any leakage from a chlorine cylinder is quickly advertised by this fact. Some of the properties of chlorine gas are as follows:

A yellowish green gas
Has a sharp pungent odor
Is about 2½ times as heavy as air
Is easily condensed to a liquid
Is inactive to metals when dry and can be stored indefinitely in steel cylinders
Is very corrosive to most common metals when wet. Since it is usually employed dissolved in water, it must be measured and carried through non-corrosive materials such as glass, rubber and silver

Is extremely irritating to the membranes in the nose, throat and lungs. Therefore, great care must be exercised in handling and applying it.

In normal water works operation, if the treatment plant is one that is visited once a day, the operator knows the minute he opens the door whether or not any chlorine leak has developed. If that pungent, piercing odor of chlorine greets him—he doesn't get excited. He kicks the door open and retreats to the windward. He probably plants his posterior on a comfortable stump and lights his pipe. When the tobacco burns down he strolls over to the open door and warily sniffs the air. If the air has cleared sufficiently, he goes in and makes his investigation as to the cause of the trouble. If the air has not cleared and the chlorine gas still pours out through the open door, he again retreats to clear air, breathes deeply a few times, fills his lungs with fresh air—holds his breath, and goes into the building to shut off the main chlorine tank valves. It may be necessary to make two or three trips to get all the gas shut off. It is better, of course, to make a dozen trips than to stay in the building breathing chlorine.

Locating Chlorine Leaks.

Chlorine leaks, however, should NOT be hunted by the sense of smell. In checking up for leakage a small swab which has been dipped in a strong ammonia solution should be run around joints, unions, etc., where leakage is suspected. White fumes of ammonium chloride will then indicate the chlorine leak. When the position of the leak is located, the chlorine equipment should be shut off and the leak repaired by tightening the joints, replacement of gaskets, etc., as indicated.

When chlorine leaks are discovered, some of the precautions to be observed include:

1 A gas mask should always be used, if available, when operator enters atmosphere containing chlorine gas.

2 Anti-spasmodic mixture:

Excerpt from letter written by A. E. Griffin
under date of April 9, 1936
on subject of chlorine hazards

"In looking over our Anti-Chlor formulae which we have available, I find that there is only one which is widely recommended. This reads as follows:

Water	1485 cc
Sugar	45 grm
Tr. Lavender Co.	37cc
Sp. Ammonia-Aromatic	56 cc
Alcohol (Ethyl)	333 cc
Oil of Peppermint	37 cc
Sp. Chloroform	55 cc

"Add oil of peppermint to the Alcohol, then the Sp. of Chloroform, then Sp. of Ammonia and Tr. Lavender Co, in the order given. Stir after each addition. Next add this mixture to the water in which the sugar has been dissolved, label "ANTI-CHLOR". Shake well before using. Dosage, one tablespoon at 15-minute intervals until relief is obtained, or for one hour. Keep patient quiet and warm. To make Sp. Chloroform, add 60 cc. Chloroform to 940 cc grain alcohol. This formula was recommended by L. L. Hedgepeth of Penn Salt Co., Philadelphia, Pa., and appeared in the November, 1934 Journal of the American Water Works Assoc. This same formula has been recommended by the American Water Works Assoc. Committee on Chemical hazards in water plants, which appeared in the September, 1935 Jl. A.W.W.A.

"This formula is recommended only for the very mild cases, and should the patient be unconscious or not breathing, the prone pressure method of producing artificial respiration is recommended. Do not use a Pulmotor or other mechanical means of resuscitation, because of the danger of rupturing the lungs. If the patient is conscious, give one of the following drinks:

a Hot black coffee

b ½ tsp. Essence of Peppermint in ½ glass of hot water

"Alcohol drinks are not recommended. The drinking of warm milk or cream will usually relieve throat irritation. Inhaling steam from boiling water to which one tsp. Tr. Benzoin Compound has been added is quite helpful in relieving coughing and difficulty in breathing."

3 Apparatus, chlorine lines, cylinder, and auxiliary cylinder valves should be frequently tested for leaks.

Chlorine Cylinders.

Every chlorine tank is fitted with a fuse plug which melts at a temperature of 157° to 162°. Because of this, it is wise to keep the cylinders away from heat. DO NOT locate cylinders next to a steam pipe or radiator.

There is no danger of a chlorine cylinder exploding while handling it. If a cylinder is dropped, the main cylinder tank valve might be broken off, thus permitting the chlorine to escape. The protecting cap should, therefore, always be in place when chlorine cylinder is moved.

The 100 and 150 lb. cylinders filled with these amounts of chlorine weigh respectively approximately a total of 200 and 275 lbs. Their shape is such that it is somewhat difficult for one man to handle a full cylinder. The only recommendation made here is to study your individual needs, then rig up block and tackle or a chain fall for lifting the cylinders. Any lateral or horizontal movement of the cylinder is readily accomplished by rolling the cylinder in the vertical position in the same manner as a full 40 qt. milk can is rolled.

What Is a Chlorinator?

A chlorinator, regardless of type, is a metering device designed to measure the rate of feed of chlorine in any of its numerous forms as it is applied to water or sewage.

Methods of Applying Chlorine.

A. **Solution Feed.** Solution feed is generally recognized as the best and most effective means of applying chlorine. In this procedure, a predetermined amount of chlorine gas is continuously mixed with an auxiliary supply of water by means of a chlorinator which accurately controls the rate of feed and effectively forms the chlorine solution which is then applied to the water to be treated. Chlorine gas will mix with water and in a very efficient injector will form a solution having a maximum concentration of 0.3% or 3000 parts per million.

Solution feed equipment requires a differential pressure to operate. In many cases solution feed can be applied in pipe sections of the water supply system by taking water from the upstream side of a valve and applying chlorine solution on the downstream side (see technical publication No. 235). For this case, the valve

must be partially closed and to such an extent, that the loss of pressure through the throttled valve will reduce the pressure in the pipe line below the valve to approximately 1/3 of that existing in the pipe section above the valve. This pressure relation or differential is generally adequate so the chlorinator can then satisfactorily function under the conditions stated above.

In other cases, a water supply from a source at higher pressure may be available for injector operation. In still other cases, a booster pump may be required. The discussion above presupposes that pressure gauges will be available. In actual practice they generally are not available and its is necessary to do a certain amount of guessing. Therefore, the production of a differential pressure usually involves a close watch of the chlorinator, and if the chlorinator tends to backfire or fails to function, it is a good indication that a sufficiently high differential does not exist and that the valve in the main must be throttled still further.

B **Direct Feed.** Direct feed is the application of dry chlorine gas directly into the water, utilizing the pressure normally present in the chlorine cylinder to force the gas through the chlorinator to the point of application. Direct feed of chlorine may have to be used in cases where sufficient water at proper pressure to operate an injector, cannot be obtained by any reasonable means. Care must be used when direct feed is employed to limit application to a rate which will insure all chlorine being absorbed. This is difficult to determine because chlorine is not readily soluble in water. Considerable agitation and mixing must be used or the gas must be broken into very small bubbles to cause absorption. Many factors such as the size of gas bubbles, temperature of the water and the differential in pressure between water and gas all affect the solubility and make general rules unreliable, if not completely impossible. For these reasons, direct feed should be used ONLY in cases of emergency which eliminate all possibility of using solution feed. In any event, chlorine feed rates must be watched very carefully and every means taken to make sure that none of the chlorine remains as a gas to collect in valve bonnets or other high spots in the line. Serious corrosion will result if brass or bronze valve stems come in contact with chlorine gas.

C **Hypochlorites.** Hypochlorites are known under various names, viz: calcium hypochlorite, sodium hypochlorite, bleach, high-test hypochlorite, Javelle water, Chlorox, Zonite, Surchlor, B-K, H-T-H, Perchloron and C-C-H. These various products are avail-

able in powder or solution form and are chemical combinations of chlorine with either sodium or calcium.

Sodium hypochlorite is available in most localities under the name of laundry bleach. It varies in strength from 3 to 15% available chlorine, by weight. Commercial calcium hypochlorite is available in powder form and is also furnished in various strengths. The standard chloride of lime available in most grocery stores contains approximately 24% of available chlorine while the so-called high test hypochlorites contain an average of 70% available chlorine.

Control of the rate of feed and application, which is just as important in this instance as with any other form of chlorine, is most effectively obtained by means of a Hypochlorinator (see technical publication No. 178 and drawings No. 302-22-C and 302-17-C) or other calibrated pumps designed for the accurate application of chemical solutions and for operation against pressure. Power for operation is often a problem in emergency work. Many times there are no electric outlets available within a reasonable distance of the selected point of application. A water operated Hypochlorinator can be successfully employed in these cases or any small gasoline engine operated pumping unit.

Possible Situations.

A **Pumped Supply from Stream.** If you have a gasoline engine driven pump and if you have a chlorinator and if you have a source of water, it is possible to pump potable water directly into the mains, possibly through a fire hydrant as shown on page 3 of technical publication No. 235, covering the Emergency Portable Chlorinator. Note in this case that solution is being used. A water supply is taken from the discharge of the gasoline engine driven pump and the chlorine solution is carried back to the pump suction where the pressure is of a negative value. The reason for doing this is obvious if you consider that the water is doing work passing through the injector and that the easiest point to apply chlorine is very obviously at a point which is under a partial vacuum.

If the pressure in the discharge of the gasoline engine driven pump does not exceed 20 lbs., it would be possible in this case to use direct feed of chlorine. However, it would not be as desirable as solution feed FOR A NUMBER OF REASONS WHICH WILL BECOME APPARENT IF YOU EVER USE THESE TWO METHODS. Again note that but one cylinder is shown hooked up to the apparatus. If the capacity exceeds 50 lbs. for an

extended period of time, it is desirable to hook up additional cylinders for each 40 or 50 lbs. increase in capacity.

If a chlorinator of the gas type is not available but some hypochlorite in any one of its numerous forms is on hand, it is possible to chlorinate water with a hypochlorinator or other small pump, as previously described and to produce water which will be just as acceptable from a bacteriological standpoint, if care is exercised and if the chlorine content of the hypochlorite being used is known.

Only a few months ago the reservoirs at Hudson, New York became dangerously low due to a break in the main following a cleaning operation. Before repairs could be made it was necessary for the City to connect two fire engines and pump from a muddy stream into a main which happened to be nearby. In this case, the two fire pumpers had separate suctions dropping into the stream and discharged into a common header which was connected to the main. A Portable Emergency Chlorinator was used for this job and was connected up as solution feed. A connection was made on the pump discharge and a 1″ line run to the chlorinator. The solution hose was connected to one of the pump suctions. As this was a rubber suction line, it was necessary to tie the hose along the line and have it discharge directly at the end of the suction line near the suction strainer. This installation operated several days before the City was able to make permanent repairs and resume operation of their regular system.

Operating troubles developed on this job which are very common in this type of installation, so the following discussion becomes desirable. As stated, the two fire pumpers were pumping from a stream which was very muddy. A short time after the equipment was placed in operation, the strainer screen on the injector of the chlorinator clogged completely. The injector ceased to function and chlorine gas escaped around the water seal of the unit. This caused considerable excitement until the source of the trouble was located. Because of the dirty water, it became necessary to clean the strainer and injector several times, and to prevent further trouble it was finally arranged to clean the injector at intervals of about one hour. This condition is very apt to happen whenever dirty water is being pumped, so it is important to make regular orthotolidine tests to be sure that the chlorinator is operating properly.

The following is a typical case of emergency installation for which it is necessary to make use of any type of emergency or standby equipment that may be available. Much valuable time is saved if people who are already familiar with the equipment are

on the job when emergency installations like this are to be made. Stand-by fire pumps are frequently found in industrial plants throughout New York State. A few years ago when a nearby town was completely out of water, it was necessary to use such a unit. This was a gravity supply consisting of two reservoirs. Both reservoirs were dry and the town was without water or fire protection. A solution feed chlorinator was installed at an emergency pumping station which had not been used for several years. After the work was completed, it was found that the pumps were broken and could not possibly be started in operation for some weeks. An immediate investigation was made to find out what emergency equipment was available in the vicinity and it was found that an industrial plant in the town had an installed fire pump. This pump was rated at approximately 750 gals. per minute and it required only an hour or so to move the solution feed chlorinator and install it. A water line was then connected from the pump discharge to the chlorinator and a tap made in the suction of the fire pump. As there was no connection between this fire system and the town mains, several fire hose lines were run from the pump discharge to nearby fire hydrants. The fire pump and chlorinator were both started and in a short time safe water was again flowing through the town system. This emergency installation remained in service for several days until the town obtained suitable pumping equipment to tide them over.

Whenever an emergency arises, it may be necessary to obtain water from some temporary source by means of any available equipment. This was the case in a small town in central New York State. The main gravity supply was washed out by a serious flood. The village had a standby well which had adequate capacity to fully supply the need, but the well was completely flooded and considered unsafe for use without chlorination. A solution feed chlorinator installed at a nearby sewage plant was requisitioned. This unit was removed from the sewage plant and installed at the emergency well. A ¾″ water line from the pump discharge was connected to the chlorinator, likewise a chlorine cylinder, and the solution hose was dropped down the well casing to a point about 30 ft. below the surface of the ground. As nearly as could be determined, this was the approximate location of the pump suction. The pump was of a deep well turbine type, making it necessary to drop the hose down the well. If it had been a shallow well pump, the suction side of the pump could have been readily tapped and the chlorine solution applied at that point. The pump and

chlorinator were started and the water pumped to waste for a few minutes, following which orthotolidine tests were made and the chlorine machine adjusted to give the desired residual. THE CHLORINATOR WAS REMOVED FROM THE SEWAGE PLANT, INSTALLED AT THE PUMPING STATION AND THE ENTIRE INSTALLATION PLACED IN OPERATION WITHIN THREE OR FOUR HOURS.

B **Main Sterilization.** In nearly all cases it is necessary to sterilize mains under some pressure, and after the main is sterilized it is obviously desirable to keep the main under pressure so that the ground water will be kept out. Therefore, in main sterilization, selection of apparatus is more or less limited and simple, and home-made devices cannot as a rule be used for this purpose.

Assume that a 1000 ft. extension or a 6″ cast iron pipe line is to be sterilized and that this section of pipe is valved at both ends. Assume a hydrant to be located just upstream of the first valve and a second hydrant similarly installed on this particular section of pipe just above the downstream valve. Assume further that water was allowed to fill this section of pipe and that then the valves were completely closed, retaining the pressure within the pipe, as no water was allowed to flow away.

An available emergency portable chlorinator adapts itself readily to this sterilization job. The first thing to do is to make a 1″ tap near the first gate valve and just downstream of the valve. From the fire hydrant just above the valve run a water line to the chlorinator and from the chlorinator run its chlorine solution hose line. The emergency portable chlorinator comes equipped with a silver tube to be first connected to the end of the hose line. The other end is then inserted through the 1″ corporation cock and extends into the pipe. It is desirable to have a pressure guage tapped into the 6″ pipe near the point of chlorine application, but this is not absolutely necessary.

Next open the fire hydrant at the far end of the pipe section to be sterilized, this escape of water relieving the pressure trapped within the section. Now open the first gate valve around which the chlorinator has been shunted and by using the pressure guage previously mentioned, crack this valve until pressure within the pipe section to be cleansed has risen to approximately one-third or less of the initial pressure at the fire hydrant. The chlorinator should then be started and chlorine solution discharged at a rate previously calculated to give a treatment of, say, 100 p.p.m.

The rate of treatment should be based on the rate of flow of water through the pipe section, as observed at the fire hydrant at the far end of the line, or it can be based on the calculated contents of a 1000 ft. 6" pipe which happens to be about 1500 gallons. After the chlorinator has operated for a sufficient length of time, residual tests should be made at the far fire hydrant. When these tests show a residual chlorine content of 50, 100, 150 or 200 p.p.m., depending upon local regulations, this indicates that sufficient chlorine has been carried through the full length of the pipe section treated. The chlorinator should then be shut off and the main be permitted to stand for 2 hours, 6 hours, 24 or 48 hours—again, depending upon local regulations. At the end of the specified "standing" time, the main should be flushed out with clear water by first opening the fire hydrant at the far end and then opening wide the upper gate valve near the point of chlorinator installation. The flushing of the line should continue until the residual chlorine content is again normal. Then take a bacteriological sample from the fire hydrant flow.

A common source of error in main sterilization is brought about by fire hydrant sampling. Very few people realize that fire hydrants are self draining and that when shut off, ground water enters the barrel to contaminate the hydrant water. (See technical publication No. 408) Under war-time conditions, however, probably neither long periods of detention in the pipe line nor bacteriological sampling will be considered. It is quite likely that these formalities will be eliminated and that the chlorine in the pipe line will be held only for about 15 minutes with a residual of about 10 p.p.m. The line can then be placed in immediate service, taking a chance on any harmful bacteria still being alive. The relatively low residual and short contact period is contrary to standard practice. This less exacting method has been used in London and there the record of water borne disease is better now than it has ever been in the past, in spite of all the main breaks.

Types of Machines Likely to Be Encountered.

Barrel Method. The barrel method has been used for many years where a very cheap method of applying hypochlorite is necessary. A wooden barrel is connected by pipe to a constant level box, and the flow from the barrel into this constant level box is controlled by means of a float valve. The discharge from the float box may be a wooden spigot of the type used on a beer keg, or it may be an orifice of some type, or it may be a syphon built

of glass tubing. Whatever method is used, the accuracy is quite doubtful, due to variations in strength of commercial hypochlorite and because any of these methods of discharge are subject to plugging by particles of lime contained in the hypochlorite. However, under careful supervision and constant attendance, this method can be very quickly employed when other means are lacking. Most State Health Departments publish pamphlets describing the barrel method. Nearly any kind of pump, such as a water main pressure testing pump, can be used to force hypochlorite into a main against pressure. The pump can be either hand or power operated so long as it accomplishes the purpose.

Street Flusher Method. Where large quantities of hypochlorite are needed in a hurry and where the application may be made against low pressure, it is possible to mix up quantities of water and hypo in a tank wagon and use the pump with which these wagons are equipped to pump the hypo solution through a fire hydrant into the main. This method has been used in large cities where polluted water has entered the potable water system through accidental cross connection.

Direct from Cylinder. It is possible to attach a cylinder directly to a water main. If the pressure in the cylinder is in excess of that in the main, gas will flow from the cylinder to the main. Obviously, if the pressure in the main is in excess of that in the cylinder, water will flow from the main into the cylinder. This is extremely dangerous, as all chlorine cylinders are shipped containing only 80% liquid, with 20% gas space allowed for expansion of the chlorine due to possible temperature rise. If water flows into a chlorine cylinder and fills it completely, and if at that point the valve is shut off, the entire tank will be "skin-full" and under hydrostatic pressure. A rise in temperature under this condition will produce an enormous increase in pressure and the tank will probably rupture. However, chlorine has been applied directly from the cylinder to pipe lines and to open bodies of water in many cases, and in an emergency this is one method of getting chlorine into water in a hurry. It is NOT a recommended method and obviously should be used only with extreme caution.

Emergency Equipment Furnished by Wallace & Tiernan.

A Standard lecture

B Hypochlorinators (technical publication No. 178)

There are three general types of hypochlorinators. First—and the one most commonly used—is operated by an electric motor and is designed for start and stop operation. The second type most commonly used is operated by a water motor and is entirely hydraulic in its operation. The second page of technical publication No. 178 and drawings No. 302-17-C, show a typical installation diagram of an electrically operated hypochlorinator. Drawing No. 302-22-C shows a typical installation diagram for the water operated machine. These two drawings, particularly the second one, should be carefully studied, because these types of hypochlorinators may be encountered in emergency work. On the back page of this publication complete specifications are given covering the types of machines discussed. In connection with both Type HEMP and HWM Hypochlorinators, note particularly that the maximum back pressure against which they will operate is 125 lbs. per sq. in. All of the other specifications are self-explanatory. Detailed operating instructions follow.

C Emergency Chlorination Trailer (technical publication No. 228)

The Emergency Chlorination Trailer is essentially a 300 lb. capacity chlorinator mounted on wheels. Included with the chlorinator is a gasoline engine driven pump, the function of which is to furnish high pressure water for the operation of the chlorinator injector. Two cylinders of chlorine are normally carried with this machine. At other points in this standard lecture you will note that one cylinder of chlorine should be hooked up for each 40 or 50 lbs. of withdrawal per 24 hr. day. In the case of the chlorination trailer this rule is apparently violated, but you will note that the engine operates while the cholrinator is in operation; therefore, the engine will generate necessary heat which can, if required, be retained about the equipment by lowering the canvas sides of the trailer housing. It is, therefore, obvious that a smaller number of cylinders can be used than would ordinarily be the case.

The pump is of the turbine type and it should be noted that the suction pressure is directly additive to the pressure generated by the pump itself. Therefore, if the suction pressure is 100 lbs. per sq. in. and the pump will generate 175 lbs. per sq. in., then the

total pressure on the pump discharge will be about 275 lbs. The pump capacity is 22 g.p.m. and this quantity is ample for the operation of the injector. The large quantity is also designed to keep down the concentration of chlorine in the injector water and thus secure a much better distribution in the main to which it is being applied. In other words, a low concentration and large volume is much better for this purpose than a high concentration and a small volume.

The primary purpose of the emergency chlorination trailer is to sterilize mains, and particularly mains which have been bombed out or repaired and about to be returned to service. It was actually designed solely for this purpose. However, it immediately became apparent that its usefulness would be just as extensive in peace-time as in war-time—first, because of the necessity of sterilizing ever-expanding water piping systems and second, because of the need of applying chlorine to auxiliary water supplies or sewage plants or for any other purpose.

In most cases the suction of the trailer pump is connected to a fire hydrant and, therefore, a standard fire hydrant connection is furnished with the equipment. If the unit is to be used in a number of towns, it is important that the various types of fire hydrants be investigated and that suitable caps are carried in the trailer to fit all of the various sizes of outlets. It is also desirable to carry a sufficient number of hydrant wrenches to fit the various sizes of nuts encountered.

D Emergency Portable Chlorinator (technical publication No. 235). This chlorinator is sometimes referred to as a main sterilizer and sometimes as an emergency portable chlorinator. It is supplied in three carrying cases. Two of the cases are of steel and contain the operating unit, the third case is of fibre and contains the accessories. This machine can be used either as solution feed with capacity up to 300 lbs. per day, or as a direct feed unit with capacity up to 75 lbs. per day. The range of capacity on any one meter is 7 to 1, and the lowest capacity meter which may be installed has a maximum rating of 5 lbs. per 24 hours.

When operating as a direct feed unit the back pressure at the point of application must not exceed 20 lbs. When operating as a solution feed unit, the back pressure must not exceed approximately one-third of the initial operating pressure. Usually it is desirable to operate by the solution feed method, as shown on page three of publication No. 235. Here it will be noted, the water

supply is taken to the injector from the high pressure side of a gate valve. The point of application of chlorine solution is made on the low pressure side of this gate valve, the gate valve being cracked so that the pressure cannot build up and stop the injector action. The cracked valve also furnishes a flow of water, which flow carries the strong chlorine solution through the main and finally out through the fire hydrant where samples for residual chlorine are being taken. In this case, as noted above under the Emergency Chlorination Trailer, the water supply to the injector could have been taken from a fire hydrant, thus eliminating the necessity of making one extra tap in the water main.

Note in the illustration that only one cylinder is connected to the apparatus. This is satisfactory if the desired rate does not exceed, say, 50 lbs. per 24 hours. If the rate is very high, it is necessary, as stated before, to manifold a number of cylinders, since in this instance a gasoline engine driven pump is not available to supply heat to the containers. In the illustration again, note that the fire hydrant is cracked open. Most water works men will probably argue that this is bad practice and that the hydrant should be open all the way or closed all the way—never just cracked.

E Main Sterilization Hand Book (technical publication No. 408). This book contains some material on main sterilization which has been gathered over a period of many years. It should be quite useful and is recommended reading.

General Instructions for all Types of Gas Chlorinators

Handling of Chlorine Containers.

A container holding any chlorine, either gas or liquid, should be handled with care.

Do not drop containers or permit them to strike each other violently.

When returning empty containers, close valves, testing for chlorine leaks at valve outlet. See that the protective caps for containers and valves are replaced before shipping.

Caps are provided for valve protection; such caps should be kept on containers except when containers are actually in use. Close the valve as soon as the container has been emptied to prevent entrance of moisture and foreign materials.

Do not use containers as rollers, supports, or for any other purpose than to contain chlorine.

Open container valves slowly. Use only wrenches or tools provided or approved by the chlorine manufacturers. For connecting containers use only the connections as furnished with the apparatus, as the outlet thread on the valve is not a standard pipe thread. Never force connections that do not fit.

Containers or valves should not be repaired or altered by the consumer; the owner, only, should undertake this work. It is illegal to ship a defective or leaking container. Telephone the owner or nearest chlorine plant for assistance.

Chlorine containers should be stored in a dry, protected place where they are not subject to high temperatures, and should not be stored near inflammable substances where they may be subjected to fire hazard. 100# and 150# cylinders should be stood upright but, unless space reequirements prohibit it, it is customary to store ton containers horizontally.

Chlorine Valves.

The proper handling of chlorine valves is of vital importance in all installations. When the container is in operating service for several days or more, open and close the valve once each day to prevent the threads on valve stem from becoming set in any one position. Failure to rotate the stem frequently will cause the threads to freeze in the valve body and if stem is forced at this stage, damage to the valve may result.

When opening a valve, do not give the valve stem more than 1¼ turns, and do not make a habit of using a wrench longer than 6 inches. It is unnecessary to use much force in closing valves.

WARNING: Never remove the fusible metal plug in the cylinder valve body or in the ton container head. A core of fusible metal is poured in the plug, which has a melting point of between 157° and 162° F. The fusible safety plug is designed to release the cylinder pressure in case of fire.

In making connections to chlorine valves and flexible connections, always use the proper lead gasket in the union or yoke type joints.

Test for Chlorine Leaks.

Escaping chlorine can easily be detected by its sharp, pungent odor, which is very irritating to the nose. The presence of the slightest odor of chlorine about the apparatus indicates a leak

which should be immediately stopped. A leak once started will increase rapidly in size resulting in the corrosion and destruction of the part where it occurs. Avoid chlorine leaks in any part of the apparatus. The presence of moisture at any spot or of any discoloration may be indicative of chlorine leaks. No matter how minute the leak, it must be stopped. If the leak is in a union, take up on the union at once, inserting, if necessary, a new gasket.

To locate a leak, remove the stopper from the bottle of ammonia which is shipped with the apparatus, and hold the open bottle near all joints, piping and valves. White fumes indicate chlorine leaks, the fumes being ammonium chloride formed by the contact of chlorine with ammonia. When leaks are detected, shut off the chlorine supply immediately by shutting the valves on the container, manifold, or header, leaving the chlorine shut off until the leaks are repaired. The ammonia bottle should be kept tightly stoppered or it will lose its strength and become useless.

Handling Escaping Chlorine Gas.

Physiologically, chlorine is a powerful respiratory irritant. However, in concentrations far below injurious ones, it gives warning of its presence. In any atmosphere containing chlorine short or shallow breathing should be used. Low concentrations in enclosed spaces sometimes cause nausea and coughing because workmen do not realize that it is impossible for them to become hardened to continued exposure. Chlorine produces no cumulative effects and complete recovery from mild exposure usually occurs. As chlorine is particularly irritating to persons afflicted with asthma and certain types of chronic bronchitis, such persons, especially, should avoid exposure.

It is important that some form of protection be provided for emergencies. For this purpose, a suitable gas mask should be at hand and located at a readily accessible point outside of the area likely to be affected in case of accident. Several types of gas masks approved by the U. S. Bureau of Mines and suitable for high concentrations of chlorine are available.

The instructions accompanying a mask concerning its care and use should be obeyed implicitly. Everyone who is in danger of being accidently exposed to high concentrations of chlorine should be provided with a gas mask, preferably to be used by no one else. He should be familiar with the instructions accompanying it and trained to hold his breath and to put the mask on quickly and

properly. Periodic strict inspection and maintenance of approved gas masks are essential.

When chlorine is noticeable in the atmosphere either by sight or smell, the following immediate precautions should be taken:

Avoid panic: Warning of the presence of chlorine is given immediately by its pungent odor and greenish-yellow color.

Refrain from coughing.

Keep mouth closed.

Avoid deep breathing.

Keep the head high as chlorine seeks the lowest possible level.

Withdraw from the affected area. The odor of the gas is so disagreeable in minute quantities that all persons in the affected area would be aware of its presence.

If a leak develops in a cylinder valve, be sure the leaking cylinder is upright. This will prevent the escape of liquid; and under these conditions vaporization diminishes rapidly, as natural chilling will take place and the escape of chlorine into the air will then be slow.

Promptly remove persons affected by chlorine to the open air and away from all chlorine gas: place the patient flat on his back. Keep patient warm and have head slightly elevated.

Call physician immediately.

Provide first aid as may have been prescribed for emergencies by your company physician, pending his arrival.

Instructions for Auxiliary Cylinder Valve.

Test valve frequently for leaks. Should a leak develop around the valve stem remove the control handle A, then tighten nut B by turning to the left, left hand thread until the leak is stopped. Use wrench not over six inches long and do not put excessive strain on threads. Under no condition remove the packing nut B. Next replace control handle on stem and screw handle down on the valve body until the valve is closed. Do not use a wrench on the handle of the valve.

The above operation may be carried out while the equipment is in operation. In case the outlet union from the auxiliary cylinder valve is not connected up to the equipment, the plug F must be inserted in the outlet union, making sure that the gasket L is in place before the above adjustments are made.

The stem position should be such that the stem C closes against

the body H before the handle A screws on to the body H far enough to reach the limit of its threads. The position of stem C can be adjusted by removing handle A and screwing it on to stem C backwards, using it as a means of pulling the stem out or pushing it further into the valve body.

General Service Notes on Care of Equipment.

All connections should be tested each day for signs of chlorine leaks—NO LEAKS OF ANY KIND SHOULD BE PERMITTED. Green deposits or color on the metal parts of the equipment indicate the presence of free chlorine. There should be no odor of chlorine at the apparatus, except when a connection is broken for making changes. Test for the leaks with ammonia. Stop every leak as soon as discovered.

All openings in the apparatus should be plugged or closed up whenever any connection is broken even for a short time. This will prevent dampness getting into the apparatus and causing trouble. Deposits will form much faster in presence of moisture.

Do not damage the heads of screws or bolts. Use proper size tool when removing screws or bolts. Since these are not often removed, any bolt or screw will freeze slightly and if the head is deformed great difficulty and delay will result.

Use Dixon's Graphitoleo No. 692 on all hard rubber threads before assemblying them to prevent the parts freezing together. Do not use mechanical tools for tightening threaded hard rubber parts together. Hand tightness is all that is required.

Do not use water when cleaning any part of the apparatus except glass parts, or parts normally in contact with water. This is important. Make sure that all metal parts which come in contact with chlorine are dry. When it becomes necessary to clean out deposits in any part of the apparatus use carbon tetrachloride (Carbona), chloroform, or wood alcohol. Do not use grain or denatured alcohol, ether, gasoline, or any petroleum distillates.

Keep a plentiful supply of gaskets on hand in order to keep the union connections in good condition and tight without undue straining of the unions or fittings.

Water Operated and Electric Hypochlorinators

Effect of Hard Water on Hypochlorinator Operation.

Mixing Sterilizing Solution. When the water used to dilute or mix sterilizing solution for the W&T Hypochlorinator contains what is commonly termed "hardness," it will be necessary to observe certain precautions. In order to precipitate as much as possible of this "hardness" previous to the solution passing through the Hypochlorinator, we recommend that soda ash or what is more commonly known as washing soda, be added to the sterilizing solution and all precipitate allowed to settle. The amount of soda ash to be added can be determined experimentally by observing the precipitate. A slight excess is not in any way harmful. Certain types of hardness will precipitate without the washing soda.

Obviously the solution which passes through the Hypochlorinator must be clear so as not to interfere with the action of the valves. In cases of this kind, therefore, a second crock should be used and the clear solutiton siphoned over to this second crock from which the Hypochlorinator will draw.

Cleaning Hypochlorinator. If difficulty is observed in pumping the solution under circumstances where hard water is known to exist, we recommend that the diaphragm and valves be removed for cleaning. The effects of hard water are indicated by a white coating on all parts in contact with the sterilizing solution. This is most easily removed by soaking the parts in 5% hydrochloric acid which may be obtained in any drug store. The commercial form of hydrochloric acid, known as muriatic acid, is acceptable.

Clogging of Solution Tube. Regardless of the preparation of the sterilizing solution, where this solution joins the water being treated and that water contains considerable hardness, there will be a deposit formed inside the silver solution tube used as the connection between the Hypochlorinator and the water main. In time this will completely plug this tube and the deposit must be removed. Where this condition is known to exist, cleaning of the solution tube should be a routine matter.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lessons No. 9 and 10

To be reproduced locally for distribution to Class Members

Operation and Care of Valves and Hydrants and Operation of Chlorinators and Handling of Chlorine

LESSON 9

There should be a systematic plan of inspection and maintenance of valves in a water system. Valves used in water works systems are, with few exceptions, of the type known as gate valves. Most valves are so constructed that they close on turning to the right. Some close by turning to the left. Valves should be operated slowly both in closing and opening. The location of all valves should be accurately recorded on maps, sketches and blue-prints.

Hydrants also require periodic inspection and care. A hydrant is a valve built into a vertical pipe. Most hydrants have a directional arrow showing which way to turn for opening or closing. Undue force should not be used in opening or closing. Hydrants should not be used by the public without proper authorization. Hydrants are provided with an automatic drip mechanism which is intended to keep them from freezing in winter weather.

LESSON 10

Introduction. All persons should be instructed to boil drinking water when normal service is interrupted by bombing or sabotage. The first instruction that should be given to a class of auxiliary operators would be in the operation of any chlorinating equipment in use in their own water supply or available for emergency use from nearby swimming pools, sewage or industrial plants. There are so many varieties of chlorinators that it is impossible to go into a detailed description of each type. The application of chlorine in emergency treatment as well as in normal operations must be achieved by an accurate method. Extremely small quantities of the chlorine must be controlled within narrow limits for even fairly large volumes of water.

Chlorine and How to Handle It. Chlorine gas is compressed or liquefied and stored in steel cylinders under pressure. When the chlorine cylinder valve is opened, the gaseous chlorine present flows

out of the cylinder and is in turn replaced by gas evaporating from the surface of the liquefied chlorine within the cylinder. Forty to 50 pounds per day of chlorine will evaporate from a single cylinder. Do not apply heat directly to a cylinder to increase the rate of evaporation, because the fusable plug in the cylinder valve melts at 157° F. Rather connect additional cylinders to the chlorinator when larger amounts of chlorine are needed.

Chlorine gas is non-poisonous and non-explosive, and it can be handled with complete safety. It is readily detected by its distinctive odor even in minute concentrations of it. Some other properties of chlorine are as follows: heavier than air, easily liquefied, corrosive to most metals when wet, irritating to membranes of the nose, throat and lungs.

When a chlorine leak occurs, do not attempt to trace it down with the sense of smell. In checking for leakage a small swab which has been dipped in a strong ammonia solution should be run around joints, unions, etc., where leakage is suspected. White fumes of ammonium chloride will be produced, indicating the position of the leak. Proper repairs—tightening the joints, replacement of gaskets, etc.—should be made in order to eliminate the leak.

The following are some *precautions* to be observed where chlorine is used:

1. A gas mask should be used when available if there is chlorine gas in the atmosphere.
2. Anti-spasmodic mixture should be prepared for use in reducing coughing following exposure to chlorine gas.
3. There should be frequent testing for leaks of cylinder, valves, chlorine lines, and apparatus.
4. Do not locate chlorine container near heat, steam pipe, radiator, etc.
5. Keep the protecting cap in place when moving a cylinder of chlorine.

What is a Chlorinator? A chlorinator, regardless of type, is a metering device designed to measure the rate of application of chlorine in any of its numerous forms as it is applied to water or sewage.

Solution Feed is widely considered to be the most effective means of applying chlorine. Chlorine gas will mix with water and, in a very efficient injector, will form a solution having a maximum concentration

of 3000 parts per million. As pointed out in previous lessons, solution feed equipment requires a differential pressure in order to operate. If the chlorinator tends to backfire or if it fails to function, it is good indication that a sufficiently high differential does not exist.

Direct Feed is the application of dry chlorine gas directly into the water. When direct feed is employed care must be exercised to limit application to a rate which will insure that all chlorine is being absorbed. Chlorine feed rates must be checked very closely and care must be exercised to make certain that none of the chlorine remains as a gas to collect in valve bonnets or other high spots where serious corrosion of brass or bronze material may result.

Hypochlorites. Hypochlorites are known under various names, viz: calcium hypochlorite, sodium hypochlorite, bleach, high-test hypochlorite, Javelle water, Chlorox, Zonite, Surchlor, B-K, H-T-H, Perchloron and C-C-H. These are available in either powder or solution form. Control of the rate of application of hypochlorites is most effectively obtained by means of a hypochlorinator or other calibrated pumps designed for the accurate application of chemical solutions and operations against pressure.

Possible Situations.

Pumped Supply from Stream. Having the combined use of a gasoline engine driven pump, a chlorinator and a source of water, it is possible to pump potable water directly into water mains through a fire hydrant. There have been instances of emergencies during which fire engines have pumped water from a stream into a main which happened to be nearby.

Main Sterilization. In nearly all cases it is necessary to sterilize mains under some pressure. After completion of the sterilizing, it is obviously desirable to keep the main under pressure so that ground water will be kept out. In main sterilization, homemade devices cannot as a rule be used, although the selection of apparatus is more or less limited and simple. Chlorine, after it is injected into the main in doses of at least 50 p.p.m., should be allowed to stand in the main for 2, 6, 24 or 48 hours, depending upon local conditions and the urgency of the situation. At the end of the specified standing time, the main should be flushed out with clear water, the line should be flushed until the residual chlorine content is again normal, then a bacteriological sample should be taken.

It is quite likely that, under war-emergency conditions, these long periods of standing time would be reduced to 30 minutes at a chlorine residual of 10 p.p.m. The line would then be placed in immediate service. The relatively low residual and short contact period are contrary to standard practice, but the method has been used in London and the record of water-borne disease is better now than ever in the past in spite of the great number of main breaks.

Types of Machines Likely to be Encountered.

Barrel Method. In the barrel method a wooden barrel is connected by pipe work to a constant level-box. The flow from the barrel into this constant level-box is controlled by means of a float valve. The discharge from the float box may be a wooden spigot of the kind used on a beer keg, or it may be an orifice of some type, or it may be a siphon built of glass tubing.

Street Flusher Method. When large quantities of hypochlorite are needed in a hurry and when the application may be made against low pressure, it is possible to mix quantities of water and hypochlorite in a tank wagon and use the pump with which these wagons are equipped to force the solution into a main through a fire hydrant. Ordinarily, however, portable pumps or fire engines are needed to force the solution into a hydrant against normal pressure.

Direct from Cylinder. The method of attaching a cylinder directly to a water main is effective if the pressure in the cylinder is in excess of that in the main. If the attachment is made when the main pressure is greater, there is a serious danger that water will enter and cause very rapid corrosion and rupture of the cylinder.

Hypochlorinators. Two types of hypochlorinators frequently encountered are briefly described as follows:

1. The most commonly used is operated by an electric motor and designed for start and stop operation.
2. Another that is commonly used is operated by a water-actuated piston or diaphragm.

Emergency Chlorination Trailer. The primary purpose of the emergency chlorination trailer is to sterilize mains, particularly those which have been bombed out, or repaired, and about to be returned to service. It was actually designed for this purpose, but it became

immediately apparent that its usefulness would be just as extensive in peace-time as in war.

Emergency Portable Chlorinator. The emergency portable chlorinator is sometimes referred to as a main sterilizer. This machine can be used either as a solution feed unit with a capacity up to 300 lbs. per day or as a direct feed unit with a capacity up to 75 lbs. per day.

CLASS LESSON NO. XI

Operation of Pumps

SYLLABUS FOR CLASS TRAINING SESSION NO. 11

2 Hours

Subject. Operation of pumps.

Instructor. Instruction preferably should be given to a combined group of auxiliaries from all towns and villages of the county. A water works superintendent having good knowledge of the care and operation of pumps should serve as instructor.

Scope. *First hour:* Lecture on the operation of various types of pumps: centrifugal, piston, portable, etc. Discuss suction lift, suction and discharge heads, capacities, etc. Discuss lubrication, care and maintenance. Use charts or blackboard sketches to illustrate principles of operation.

Second hour: Demonstration of operation of a water works pumping station, Venturi meters, recording equipment, switchboard, etc.

Prior to lessons No. 12 and 13 each local water superintendent should have available for distribution to his auxiliaries a well conceived plan for action to be taken by the auxiliaries in event of air raid alarms or actual emergencies. The instructions should include directions as to where and to whom each auxiliary is to report and what his duties will be under various simulated conditions. The plan should include also a list of all emergency water supplies which may be used and the exact arrangements outlined for their use.

Reference Text for Lesson.

The object of this lecture is to familiarize the student in a general way with the fundamentals of pumps and their operation and work done in pumping. The material will be presented in such a way as to give the student enough information to enable him to select from several possible choices a pump for some particular piece of work, or to give enough information to some central control agency for the prompt dispatching of proper pumping equipment.

This is particularly important in water supply work during times of emergency. We have had instances in the past of otherwise intelligent men trying to use entirely unsuitable pumping equipment for the development of emergency water supplies, delaying service and causing unnecessary confusion as a consequence. It is not uncommon, even on ordinary repair jobs, to see the work hampered because of

poor choice of pumps used for de-watering trenches, diversion of surface water at stream crossings and the like.

In time of grave emergency, proper selection of a pump to maintain fire service from auxiliary sources may mean the difference between serious or slight losses in life and property.

All pumps are used for raising liquids—in our case water—from a lower elevation to a higher elevation. In water supply work, they are used where it is necessary to move water that cannot be moved by gravity in sufficient quantities and at proper pressures for the needs of the particular moment.

In moving this water, work must be done and some source of power directed into some type of mechanical motion that will impart the energy of the power source to the water. The pump is the instrument used for this purpose.

A pump alone, without some source of power, is of no use. We must keep in mind, therefore, the common power sources for pumps to help us in judging the fitness of a pump *and* power unit for some particular piece of work.

Three Things That All Pumps Do.

To determine the applicability of a pump for any piece of work, we should *first* make some reasonable estimate of the *work* we expect the pump to do in terms of *quantity of water, time* and *elevation.* These three things must always be in our mind, and, until we have made reasonable measurements or estimates of these three things, no intelligent choice of a pump or power source can be made. Even if we ourselves cannot evaluate these factors and translate them by mathematics to equipment specification, we can school ourselves to visualize all of them in at least reporting some given emergency situation to our superiors or to the person from whom advice is asked.

If you are faced with a street crater and jammed valves, making de-watering difficult, you *can* go to a phone or send a messenger and say, "Send me a pump." You can also use your head, sound the crater, guess at the overflow in the gutter and give some idea of the size of the crater. This is information enough for someone to dispatch to you a piece of equipment that *can* handle your job. There won't be any instances of a "boy to do a man's job."

If you *must* establish an emergency auxiliary water supply, you can rush to a phone and say, "Send me a pump," and then be asked a lot of questions for which you have no answer. But if you have determined in advance the elevation of the auxiliary source, necessary service pressures, population in the area, and know the length of temporary

hose lines to connect to the existing systems you have intelligent answers to give.

Pumps are pieces of machinery designed for a specific type of work. Work means quantity of water, time in which the quantity is to be handled, and height to which it is to be lifted. Evaluate your emergency situations in these terms, and if you cannot convert these into a pump and power need, you will have the basic information necessary for someone else to help you intelligently and with a minimum loss of time.

Some Examples in Choosing the Right Pump.

We do not want to go into too much mathematical detail but, to clinch our points some simple example seems in order now to illustrate the need for knowing the three factors mentioned.

Let us say you have been sent to handle a job and find a crater that must be de-watered before your gang can work. You estimate it to be thirty feet in diameter and ten feet deep. The gates on both sides have been closed, but water is running over the lip of the crater into the nearby gutter in a steady stream. The gutter is not running full, say about an inch deep. The location of the crater with respect to the rest of the system is known.

This information alone, meager as it may seem, immediately puts the person in charge in a position to judge the situation. He knows he must handle about 50,000 gallons of water, plus some small valve leakage, and provide for steady pumping during operations. His low lift pumps can handle the job all through without lowering into the crater. If the work is important, he may want to be at the work in two hours. He, therefore, needs a pump capable of handling $50{,}000/120 = 410$ about 400–500 gallons per minute. His solution will probably be to send you one or two high capacity pumps and one small capacity—self priming unit. He knows, within a reasonable time, when each unit can be released for use at some other point. Your information has been of value to the whole repair scheme, expedited your job, and helped clarify the entire situation.

The development of auxiliary water supplies from emergency sources calls for more study and, hence, more information. Every superintendent should know the relative elevation of possible emergency sources and his regular storage system. He should know the elevations of various points in his distribution system and the minimum service pressure necessary. He must have some idea of the quantity of water he needs, or be in a position to make some reasonable guess. Adequate maps of the distribution system should be available.

Under any other conditions, the choice of a pump or power source can not be made intelligently. In these matters, there should be more practical thought given to the job we may have to face.

We have seemingly digressed from the actual discussion of pumps, but, if we have made clear the three things that all pumps do, we have clarified your mind. Pumps, when given motion from a power source, are meant to move a given quantity of water in a given time to a desired elevation.

Classes of Pumps.

To do the various jobs required of pumps, we have available two general classes of pumps: (1) *displacement pumps* and (2) *centrifugal pumps*. Let us discuss these in terms of use, prime movers, etc.

Displacement pumps may be of two types: the *reciprocating type,* that is a straight motion of a piston back and forth with suitable valves, or the *rotary type* which displaces water by the revolution of gears in a closed box.

The reciprocating pump is reliable in operation but, in the field of work of the water works auxiliary, would not be encountered very often in the water-works repair field, as a power pump, with one exception. The *diaphragm pump,* designed to pass highly turbid—or muddy—water, is sometimes used for handling water encountered in excavations. This, manually operated, with a foot valve on the suction hose, is a reliable and useful pump for small quantities of water. Manually operated, the rate of pumping can be adjusted to inflow. Generally light, it can be "man-handled" into tight corners. With some source of power, the pump can handle small quantities of water with a low lift.

Generally, this pump would not be suitable for rapid de-watering of a crater or excavation, but it has its field in holding down the water seeping in after larger pumps have done their job. It is easy to repair and simple to operate. It will operate only on low suction lifts, not usually in excess of twenty feet. When powered, it usually is served by a one cylinder gas engine.

For auxiliary water supply work, reciprocating pumps of sufficient capacity rapidly assume a weight and size that makes fixed installations a necessity. This type of pump may be a single acting—or double acting—piston in a cylinder, alternately making a suction and discharge stroke. Atmospheric pressure forces water into the cylinder on the suction stroke, and the piston forces water out on the discharge stroke.

Speeds are not high and deliveries in mobile sizes are small. The prime mover in most of the older single or double action pumps of this type is steam, although low-speed, single cylinder gas engines can be used with a belt drive in some cases. In temporary use, we have found the problem of handling vibrations a hard one, and it pays to take time to build a firm platform on which to brace the pump.

In some mobile sizes for small delivery, the popular Triplex or Duplex pumps may be found. These consist generally of two or three pistons operated by a crank shaft and traveling through a cylinder. Speeds are low and capacities limited. In larger capacities, fixed installations are almost a necessity. Prime movers may be gas or Diesel engines, and the connection between the prime mover and the pump crankshaft may be by belt or by gears. The slow speed of the pump makes direct connections impracticable.

Practically all of these types of displacement pumps must handle clear water. The limits of suction lift are about twenty to twenty-five feet.

In thinking of displacement pumps of this type, we can remember they have certain advantages over other types. The quantity of water delivered does not vary greatly with the pressure against which the pump is operating. They are easily primed, and, if in good condition, prime themselves if the suction head is low.

The rotary pump is a type of displacement pump that is now used principally for handling oil and chemicals. It was, however, formerly used to some extent for water, particularly for fire protection. It is a relatively slow-speed machine, generally operated at from 100 to 400 revolutions per minute, and the choice of prime movers for this type of pump must be governed accordingly. In our emergency water supply work, we may encounter this type of pump in our fire engines, of which we will say more later, and in relatively smaller sizes for delivering small quantities of water at high pressures where it might be needed for the operation of chlorination equipment or injection of chemical solutions.

Centrifugal Pumps.

These are now widely used in all types of water supply work. They are called centrifugal pumps, because centrifugal change is an important factor in their operation. The centrifugal pump consists of an impeller rotating within a case. Water enters the impeller at the center, is forced outward by the vanes of the impeller as they rotate, and is discharged from the edges of the impeller into the pump case. Through

the impeller, the water receives energy present because of the velocity of the impeller rotation. The shape of the pump case transforms this energy into pressure.

Because of this construction, the centrifugal pump is usually compact. The pump may be set horizontally or vertically, depending on the design and the arrangements for its power source. Centrifugal pumps are usually described by the diameter of their discharge.

These pumps may be used when water is said to be under pressure, to raise pressure, or may be set above the level of the water from which the supply is to be drawn.

Before we go further in the discussion of centrifugal pumps, I believe we should bring out the fact that this is one type of pump for which it is necessary to have rather complete information if an intelligent choice of pumps is to be made. Some types of centrifugal pumps, distinguishable because of impeller variations, are designed only for raising of pressures and will not maintain sufficient vacuum for lifting water from the level below their setting.

Pump efficiencies vary greatly for each pump, depending on the conditions of operation. Centrifugal pumps have a definite pressure, peculiar to each pump, against which the pump will not operate. While they fill a great need in the water works field, particularly for emergency work, there is probably no other type of pump which has caused more grief, when people have been in a hurry, than the centrifugal pump, mainly because they have been asked to operate under conditions for which they were not designed.

We have a record, for instance, of a centrifugal pump which, according to the plate on the pump, was rated for 300 gallons per minute against a head of 65 lbs. This pump, powered with belts from a gasoline engine with adequate horsepower and operated at rated speed, was recently placed into service at the time of a need for quick development of an emergency water supply. The static pressure alone, against the pump, was 64 pounds. On top of this, the pump was supposed to discharge water through about 200 feet of three-inch screw joint pipe and 1,100 feet of old four-inch cast iron main before reaching an eight-inch main running about a mile to a storage reservoir. You can imagine the confusion and inconvenience this particular arrangement caused.

In other words, to go back to the first portion of this lecture, an intelligent evaluation of quantity, time and elevation had not been made in terms of the pump. In working with centrifugal pumps, therefore, familiarize yourself with the pumps you may have to deal with, and, above all, familiarize yourself with the conditions these pumps may

have to meet. Before calling for pumps of the centrifugal type, be sure to make some intelligent estimates of the work you intend the pump to do.

If you have a centrifugal pump and do not know its characteristics, the pump can be set up with a valve on the discharge line and a length of hose and a pressure gauge on the pump side of the valve. By this arrangement, you can determine the shut-off head on the pump relatively quickly. This will give the limiting point to which the pump will lift at least some portion of its capacity. By gradually opening the discharge valve and measuring the flow of water, either by means of a nozzle or a barrel of known capacity, you can determine the discharge of the pump over a range of pressure. In other words, you substitute for head due to elevation and friction, a head created by the constriction of the valve on the pump discharge. No matter how roughly these measurements are taken, the results will be of some guidance to you and probably of help until you can secure expert assistance.

The centrifugal pump may be equipped with more than one impeller, in which case it is called a two-, three-, four-, or five-stage pump, depending on the number of impellers. This placing of impellers in series, that is, one impeller discharging to another, becomes desirable when high heads are necessary.

Centrifugal pumps may be used for lifting water to any height, from a few feet only, up to as much as several thousand feet. Remember, before this statement was made, you had been forewarned that this does not mean any centrifugal pump will operate within this range. It does mean that, if you know the conditions under which the pump will operate, you can secure a centrifugal pump for almost any type of duty.

Because of the flexibility of design of centrifugal pumps, they can be made and are made to handle turbid water and even sewage which contains solids of all types. In construction work, this, then, gives the centrifugal pump some advantage over displacement pumps, particularly where large quantities of water must be handled that may contain high turbidities or foreign material small enough to pass the foot valve screen.

Most centrifugal pumps operate at relatively high speeds, allowing for direct connection to suitable prime movers and making, with electric power particularly, a rather compact pump and power unit. At the same time, they lend themselves readily to powering with gasoline or Diesel engines with relatively simple belt drives, generally through a jack shaft of some kind. This is important in emergency work,

because this type of connection lends itself easily to the conditions and materials with which we often have to work.

Rotative speeds vary all the way from 30 to 3,000 revolutions per minute, although the lower speeds, below 1,000 revolutions per minute, generally pertain only to the larger-sized pumps.

It can be seen that the centrifugal pump is essentially a high speed machine and, therefore, was not too effectively developed as long as the steam engine was used as motive power. The development of the electric motor, however, provided a source of power with speeds suitable for centrifugal pumps, and the development of the centrifugal pump followed closely that of the electric motor.

As we stated, several stages or impellers may be necessary, in a pump, to meet the conditions of its operation. The heads, against which single-stage centrifugal pumps will operate, vary with the speed. A speed of 1,750 revolutions per minute is probably the speed most used and best adapted for average conditions. At this speed, pumps designed for the job will deliver water against heads of 250 feet or more, although, usually, when a head is over 100 to 150 feet, we begin to get into the range where often it is advisable to choose a pump having two stages.

Centrifugal pumps will operate satisfactorily with suction lifts as high as 25 feet, but, if the suction lifts are over 15 feet, careful consideration must be given to local conditions. In choosing quick emergency set-ups, therefore, we should avoid high suction lifts. Along with this, care should be taken, in connecting a centrifugal pump, to avoid loose joints in the suction or high portions in the suction line where air may collect.

If we attempt to operate centrifugal pumps with too high a suction lift, we will get either no delivery or "cavitation," that is, pockets may form in the pump because atmospheric pressure cannot deliver water fast enough, through the pump suction, for the pump.

Common mistakes, made in connecting centrifugal pumps for emergency work, seem to be lack of tightness of suction lines and requiring the pump to care for too much suction lift. There have been instances of contrifugal pumps connected "wrong end to," but, if you remember that water enters the pump at the center of the impeller, you can trace out your connections without any trouble. Care should also be taken, in connecting centrifugal pumps, to check the direction of rotation, usually marked on the case. In connecting centrifugal pumps, it generally pays to use care in proper pump and power alignment.

The shaft of the impeller of a centrifugal pump, if it passes through the casing, goes through stuffing boxes. A little leakage of water

from these cells between the shaft and the packing is not harmful, and a pump with a leaking stuffing box will always run smoother and more efficiently than one on which the glands have been screwed down so tight that there is no drip.

If a pump has not been in service or is as delivered to you from the factory, it is advisable that the pump be opened and its interior examined before it is started. It is surprising how many things can lodge in the impeller of a pump, and neglect of this precaution has caused some trouble in the past.

Fire Engines.

No discussion of pumping equipment for use in emergencies would be entirely complete without speaking of fire engines. At the present time, these probably furnish us with our largest source of heavy-duty, mobile pumping equipment immediately available for service. Today, practically all of these fire engines are gasoline driven trucks.

These fire engines employ the types of pumps we have mentioned, the piston, rotary and centrifugal. All of these have proved practicable for fire engine service.

Fire engines are rated according to the quantity of water they will pump at 120 pounds net pump pressure. It is important to remember this: that they are generally purchased to deliver some rated capacity at this pressure, ½ their rated capacity at 200 pounds pressure, and ⅓ their rated capacity at 250 pounds pressure.

In talking with firemen about equipment, they will speak of sizes of pumpers in terms of pump discharge in gallons per minute. The sizes considered as standard are the 500, 600, 750, and 1,000 gallon sizes. Always remember, however, when judging suitability of equipment for a job, that this is the discharge at 120 pounds, and the proportion of flow you could expect from these pumpers is ½ of this value at 200 pounds, and ⅓ at 250 pounds.

Even these discharges apply only to pumpers which have been kept in good repair or are practically new. The National Board of Fire Underwriters expect fire pumpers, after several years of service, to deliver their rated capacity at 100 pounds pump pressure.

In using fire engines, it is generally desirable to keep the suction lift low, under 10 feet if practicable. Certainly 15 feet is about as much as we should expect, although 23 feet is the maximum.

Operating speeds of pumps on fire engines are generally designed so that the piston and rotary pump runs at speeds of from ½ to ¼ the engine revolutions. The centrifugal pump is usually geared to

the motor to operate at a higher speed, usually about 1½ or 2 revolutions to one of the motor. We might carry this ratio in our minds for use as a guide where internal combustion engines are used as a power source for various types of pumps, since, to obtain full power from these engines, it is essential they be operated at speeds that are not too low and yet not too high to introduce danger of heating or vibration.

In operating pumps, care of the power source, whether it be a gasoline engine or an electric motor, is probably the item requiring the most time, labor, and care. Fortunately, there are few people today who do not realize the need for cooling and lubrication of gasoline engines. However, with equipment as hard as it is to secure today, *we should exercise every care to see that prime movers are properly cared for.*

Here, again, we must use care in choosing our source of power for pumps to fit the pump and to fit the work we must do.

Time does not allow for too much discussion of these points. Work that electric motors will do, however, is generally stated in terms of horsepower. A little care in selecting motors and in judging their operation may save the burning out of these motors. If we attempt to raise a certain quantity of water in any certain time, through a certain pipe, work must be done. A simple equation for determining horsepower is gallons per minute, times head in feet, divided by 4,000. In other words, to pump 40 gallons per minute against a head of 100 feet, approximately one horsepower would be required.

In a centrifugal pump, this is important because of the fixed pump characteristics. It must always be remembered that, with the same centrifugal pump and the same speed, the lower the head, the heavier the load on the motor will be.

A lesson sheet has been prepared to illustrate some of the material in this discussion.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 11

To be reproduced locally for distribution to Class Members

Selection and Operation of Pumps

In order to determine the applicability of a pump to a particular piece of work, a reasonable estimate should be made of the work expected of the pump in terms of quantity of water, time and elevation. The term work as used here means the quantity of water, time in which the quantity is to be handled and the height to which it is to be lifted. Pumps are meant to move a quantity of water in a given time to the desired elevation.

Selection and Operation of Pumps.

A volunteer or auxiliary may conclude that the dewatering of a flooded bomb crater is an easy matter. The officials at a control center, however, cannot dispatch a suitable pump promptly unless they have information as to the size of the crater and the estimated amount of water entering the crater from ruptured mains, sewers, etc. Therefore, the size of the crater, the required capacity of the pump and the head against which the pump must operate should be determined before communicating with the control center.

The selection of pumps for emergency sources of public water supply should be based upon the volume of water to be pumped, the head against which the water is pumped, including the pressure on the distribution system, and the anticipated friction loss in the force main between the pump and the system. The capacity of a pump, especially a centrifugal pump, is materially influenced by pressures and speeds of operation, so characteristics of any available portable emergency pump must be carefully weighed to enable proper selection being made.

There are two general classes of pumps—displacement pumps and centrifugal pumps.

The displacement pump may be of two types:

1 *Reciprocating*—A type which utilizes the back and forth motion of a piston in combination with the valves.

2 *Rotary*— A type which displaces water by the revolution of gears in a closed box.

Reciprocating Pump. The diaphragm pump is an example of the reciprocating type. Though it may be found as a power operated unit,

it is usually manually operated to handle small quantities of water with a low lift. Generally it is not suitable for rapid de-watering of a crater or excavation, but it has its use in holding down seepage after larger pumps have been used. It has, in addition, the advantage that it can be used in confined space.

For the purpose of auxiliary water supply, a reciprocating pump takes on such dimensions and weight in order to provide sufficient capacity that fixed installations become necessary. In this case the pump is power driven. Vibration here is a problem which may be solved by building a firm platform on which to place the pump.

Small size portable duplex and triplex pumps are used, but the weight of large capacity units usually requires a permanent or semi-permanent installation with suitable foundations, etc. These types of pumps fitted with pistons and moving valves are most suitable for pumping clear water.

Rotary Pumps. The rotary pump is a type of displacement pump now used principally for handling oil and chemicals. It was formerly used for water chiefly in fire protection. In emergency water supply work this type may be installed where it may be needed for the operation of chlorinating equipment or injecting of chemical solution.

Centrifugal Pumps. Centrifugal pumps are now widely used in all types of water supply work. The action of the pump impeller and the shape of the pump case combine to impart pressure to the water as it passes through the pump. Centrifugal pumps are usually described by the diameter of the discharge. Pump efficiency varies greatly for each pump, depending on conditions of operation. Each pump has definite characteristics as to capacity and working pressure. If the characteristics of a pump are unknown, the shut-off head may be determined rather quickly by setting up a valve on the discharge line and a length of hose and a pressure gauge on the pump side of the valve. By gradually opening the discharge valve and measuring the flow of water, either by means of a nozzle or a barrel of known capacity, discharge of the pump over a range of pressure may be determined.

Centrifugal pumps may be equipped with several impellers placed in series or stages for use in obtaining high heads. They may be used to raise water to any height, from but a few feet to several thousand feet. Because of the flexibility of design of the centrifugal pump it can be made to handle turbid water and even sewage containing solids of all kinds.

Rotative speeds of centrifugal pumps vary all the way from 30 to 3000 revolutions per minute. The development of the electric motor provided a source of power suitable to centrifugal pumps. A speed of 1750 r.p.m. is probably most suitable to average conditions. At this speed water can be delivered against heads of 250′ or more, although overcoming of heads of 100′ to 150′ may begin to require a two-stage pump.

Centrifugal pumps will operate satisfactorily with suction lifts as high as 25′, but lifts of more than 15′ should be carefully considered in the light of local conditions. In connecting emergency setups high suction lifts should be avoided.

The following are some precautions to be taken in connecting centrifugal pumps for emergency work: See that suction lines are tight, that the pump is not required to operate at too high a suction lift, that connections are not made "wrong end to", and that the direction of rotation is checked and noted.

Fire Engines. Fire engines probably furnish the largest source of heavy-duty mobile equipment immediately available for service in an emergency. Each of the types of pump we have mentioned—piston, rotary and centrifugal—are employed in fire engines.

Firemen will speak of sizes of pumpers in terms of volume of water discharged per minute. The standard sizes deliver 500, 600, 750 and 1,000 gallons per minute. It must be remembered, however, that these are the discharges at 120 lbs. pressure and that the proportion of flow from such pumpers is ½ of these volumes at 200 lbs. and ⅓ at 250 lbs. In using fire engines the suction lift should be kept low, under 10′ if practicable.

Piston and rotary type pumps operate at speeds of ½ to ¼ of the engine revolutions. The centrifugal pump is geared to the motor to operate at a higher speed, about 1½ or two revolutions to 1 of the motor.

One simple fact to remember about the relationship between the prime mover of a pump and its capacity to do work is that approximately 1 h.p. is required of a prime mover in order to pump 40 gallons per minute against a head of 100′.

This relationship assumes 100% efficiency. If efficiency of 80% is assumed, the relationship becomes: 3.0 h.p. is required to force 100 g.p.m. against a head of 100 feet.

Thus 12 h.p. would be required to force 200 g.p.m. against a head of 200 feet.

CLASS LESSON NO. XII

Emergency Sources of Water Supply

SYLLABUS FOR CLASS TRAINING SESSION NO. 12
2 Hours

Subject. Emergency sources of water supply.

Instructor. Each local water department head should give this lesson separately to his own auxiliaries.

Scope. *Two hour field inspection* of all emergency water supplies which it may be necessary to use, with directions in the field as to the hookup which will be required in the event of their use.

Reference Text for Lesson.

Public water supplies should be adequate to meet both ordinary requirements and the extraordinary demands due to large fires such as may be expected to occur from time to time. Usual engineering design for the average community calls for 100 gallons per capita per day. Pumping rates or elevated storage, or a combination of both must be provided to meet peak demands at certain hours of the day. This demand may be 2½ times the average rate (gallons per minute). The fire demand, as usually calculated by fire underwriters, may be higher than the normal peak demand, may occur at the same time and be prolonged for a matter of hours.

A well-designed system of supply and distribution should serve these needs without failure. However, we are facing an abnormal emergency condition due to war and the possibility of bombing, sabotage, or both. The time, extent, or consequences of such events cannot be foreseen. We can expect, however, that there will be damage to the water supply system and, at the same time and immediately following, an abnormally heavy demand on that system.

To meet such an emergency condition, emergency water supplies should be available and plans made in advance for their effective use. This involves cooperation between water supply and fire-fighting authorities. Each must recognize the problems of the other and both must be acquainted with the necessity of protecting the public health in the use of such emergency supplies. There may be no profit in putting out a fire if it is followed by an epidemic of disease. The zeal to extinguish a fire or to maintain pressure in the mains should

always be tempered by concern for the quality of the water introduced into the mains for that purpose.

Emergency water supplies may be secured, if locally available, from the following sources:

1. Adjacent public water supply systems, through prepared connections between the systems or by temporary connections such as hose lines and fire pumpers.
2. Private supplies such as wells and storage tanks, used for industrial purposes, air-cooling and refrigeration, estate supplies, swimming pools.
3. Fire wells or cisterns—prepared emergency supplies not otherwise used.
4. Ponds, lakes, streams, tidal water-fronts, swimming pools.

Emergency water supplies must meet certain conditions to be useful in supplementing public supplies. These considerations are:

A Accessibility.

B Adequate volume, pressure, and rate of flow.

C Power and pumping facilities, fixed or temporary.

D Connections by pipe or hose.

E Means of disinfection, if non-potable supply is delivered to drinking water system.

F Freedom from toxic chemicals, silt or clogging growths.

Public Supply Inter-Connections.

By far the most satisfactory reserve source of supply is another public system. Quality and safety are known, and pressure, volume and pumping rates may be similar, or certainly more suitable than in private supplies. There is the advantage of the emergency connection having value to both systems and, therefore, a mutual interest in its development and maintenance should exist.

Such emergency connections are most practical in urban areas where density of population results in two or more public systems adjoining closely as in Nassau and Westchester Counties. In some instances, as in Nassau, it is possible for one system to have connections to five or six adjacent systems using very short pipe connections, each additional connection adding to the value of the others for all of the inter-connected systems.

Where the systems are some distance apart the cost of interconnecting may be considerable and must be weighed against the

cost and value of other means of reinforcing a particular supply. A new well, a stand-by pump, or increased storage, surface or elevated, may cost less than a long inter-connection. Long connections may also involve very large main sizes to reduce friction losses, or auxiliary pumping stations to produce an adequate flow between systems or to overcome differences in elevation.

Emergency connections should be made between supply mains wherever possible, with pipes on either side as large as possible and in any case not less than 6 inches in diameter. If the connection is used to meet a fire demand or to maintain domestic service in a valved-off area, it must be at least of sufficient size to provide several fire streams or to maintain minimum pressure on either side of the connection.

Such connections require no more than one or two gate valves which may be sealed by either or both of the parties. For emergency use, meters are not required and are a needless expense, since volumes of water can be roughly estimated for purposes either of payment or return of equivalent volumes.

Inter-connections should normally be drained in the section between gate valves. If stream crossings are necessary, the pipe may be exposed and a blow-off or drain valve located in the exposed section. It is always desirable to avoid cumbersome legal contracts and agreements and elaborate engineering plans for short inter-connections, since the cost of legal and consulting engineering services may readily exceed the actual cost of the connection.

Where considerable differences of elevation exist between two systems it may be necessary to arrange valves and fire hydrants to permit the use of a fire pumper or other emergency pumping unit, so that suction may be taken from one system and discharge made to the other. For such an arrangement a space between hose connections of 40 or 50 feet is desirable. Even though the use of a pumping unit may be anticipated, the actual physical connection of the mains should always be made, since the higher system can always supply the lower; and if the differential elevation is less than the normal pressure of either system, the lower may feed into the higher when the latter's supply and pressure is nearing exhaustion.

Emergency Use of Fire Hose Connections.

The planned use of fire hose lines in place of actual connections is objectionable in many ways. Emergencies develop suddenly and in unpredictable ways so that plans for certain water works personnel to move certain hose lines to certain points of connection may easily

be upset. The opening of a valve is a far simpler operation at a time when minutes may count in fighting fires. Furthermore, no ordinary arrangement of multiple hose lines could equal the delivery of water through a proper pipe connection. There is the added difficulty of contamination in open hose connections which cannot be readily disinfected, and also the necessity of maintaining a continuous guard over such a connection as well as protecting hose against traffic.

If ordinary foresight has not been exercised by water supply officials in making water connections at obviously favorable points of close proximity between two systems, then the use of hose lines may become necessary in an emergency. The friction losses in fire hose are extremely high—about 15 pounds per 100 feet of hose with a normal fire stream of 250 gallons per minute. A connection requiring 500 feet of hose would, therefore, be of little value until the pressure in the distressed system had been reduced almost to zero.

Hose intended for such a purpose should be kept clean by careful storage and should not be used for ordinary fire fighting or pumping of contaminated water. It must be stored at an accessible point with all necessary fittings and tools; water works personnel must be designated and carefully instructed in its use at particular locations, possibly in combination with a fire pumper as a booster unit.

Private Supplies.

For any public water supply in New York State, information resulting from surveys for cross-connections should have established a list of private water supplies containing those of such size and location as to be possible emergency sources for the public supply. Most adaptable are the major industrial supplies, if secured from wells or if purified for general plant use. Such supplies are likely to have pumps and main piping of adequate capacity to deliver substantial volumes under suitable pressures. Where such supplies are cross-connected, and therefore necessarily satisfactory as to bacteriological quality, removal of check valve flaps would permit direct delivery to the public supply mains.

Major industrial supplies are likely to be found at large factories, at plants where large volumes of water are necessary in the manufacturing processes, and at many of the new defense industry plants where large amounts of water are required for air cooling or tempering. Such water supplies are usually designed for fire protection purposes and necessarily have capacities running into hundreds of gallons per minute and developing pressures equal to or exceeding those of the public system.

Smaller but still useful private supplies may be found at ice plants, store, office and theater buildings, institutions, schools, private estates, golf courses, swimming pools, etc. Pressures in these private supplies are usually less than in municipal systems and such supplies would therefore be useful chiefly when prolonged demands on the public supply reduced pressures to their range. The small supplies just referred to and private domestic supplies, not worth connecting to the public supply, may be useful as sources of drinking water when the public supply is out, or in an area valved off, or when the public system has become contaminated.

Fire Wells and Cisterns.

In some areas where shallow ground water is readily available and public distribution systems have not been constructed, fire wells have been installed at strategic locations to which fire pumpers could make suction connections. These wells should have high yields for at least short periods of pumping and should be readily accessible, usually in streets or on curb lines. After public systems have been built, such wells have usually been retained as reserve fire fighting supplies.

Large underground cisterns have also been constructed in many communities as storage reservoirs for fire fighting. These would ordinarily be filled from sources yielding an inadequate fire fighting flow, such as small wells, small diameter service lines, or even tank wagons.

Surface Waters as Emergency Sources.

Natural surface waters such as lakes, ponds, rivers and tidal water fronts are excellent emergency sources for fire fighting if close to residential, business, or industrial areas. They have the advantage of not being limited as to quantity, but they are not usually satisfactory for pumping into distribution systems to supplement a potable supply because of the public health hazard.

Where a sizeable body of water lies in or against a fire risk area, the local fire department should plan for maximum use of such water by direct fire pumper suction. Underground suction mains leading from protected intakes to fire hydrants are desirable in some locations, particularly where shore lines or water fronts are inaccessible to pumpers or where mud or debris may be picked up by the short suction lines of a pumper. One village in Nassau County has recently had plans prepared for a series of

suction wells to be located along the tidal water front, with intake lines extending out to clear salt water.

There may be a temptation in the face of a critical conflagration for fire department officials, without health department sanction, to discharge such non-potable water by means of a pumper into a public water supply main, so that it might be delivered further inland to the suction of other pumping equipment. The public health hazards of such a practice are so serious as to outweigh considerations of property damage and it should be resorted to only when the immediate saving of human life, rather than property, is the problem.

The planned discharge of surface waters into a distribution system must, of course, include disinfection and all of the coincident precautions of warnings to the public. The emergency utilization of such supplies must, therefore, be under the direction of the water supply officials, with the advice and consent of the public health authority.

Under some circumstances of location, a swimming pool might serve as a good, though limited emergency supply, if available to direct fire-pumper suction or for discharge into a distribution system. A well equipped artificial pool with a private supply would be able to deliver through its purification system a limited amount of potable water of dependable quality.

General Considerations.

Accessibility is a prime necessity in emergency water supplies. Cross-connected approved industrial supplies are readily adapted for delivery into the public system by removal of check valves. The connecting pipes are generally large enough to permit adequate flows. Where major private supplies are not so connected, the responsibility of providing connections falls upon the local water supply authorities. Since each such connection is an individual problem, no general specifications can be outlined.

The value of an emergency supply, assuming its potability, lies in its volume, rate of flow and pressure in relation to the public supply. These factors must be carefully determined by the water superintendent. Pumping rates should be at least 100 gallons per minute, pressures should approach or equal those of the public system, and volume should be sustained for at least several days of continuous pumping.

Emergency supplies with independent power sources are especially desirable. Direct Diesel, Diesel-electric, steam, or gas engine power make such supplies available when the public supply power source may have failed. Pumps having positive displacement, such as steam-driven or motor-driven triplex pumps, can produce desired pressure, while centrifugal pumps may have discharge rates seriously reduced by increased heads.

It may be worth while to install temporary pumping units capable of delivering into the public system on supplies which are suitable as to volume and location but lacking in fixed pumping capacity.

Where otherwise usable private water supplies are not connected to the public distribution system, temporary connections may be made, properly at the expense of the public supply. If these are not made in advance and the use of the private supply is dependent upon an emergency connection, iron and steel pipe and fittings or hose lines must be used. The requirements for such a connection should, therefore, be carefully determined and recorded in advance, as to the size and number of lengths of pipe, specials, valves, etc., and the points of connection. While hose lines are more flexible, there must also be prepared the valved outlet to which hose couplings could be made.

The disinfection of a non-potable emergency supply is essential. This, likewise, requires advance planning in the assembly of a suitable disinfectant and the fittings, pumps, and apparatus for its application under various conditions. If obtainable, calcium hypochlorite (HTH or Perchloron) is most suitable. However, sodium hypochlorite (a solution in drums) is being generally supplied by jobbers at the present time and is satisfactory except that some supplies are not properly labelled and the strength of solution given as delivered to the consumers. Chloride of lime in 100 pound or larger drums or in 12 oz. cans may be used if due regard is given to the loss of chlorine on exposure of the dry mixture.

The procedure of disinfecting water supplies has been fully covered in Class Lesson No. 5. It is important to realize that a turbid water supply or one containing suspended material of any kind is difficult to chlorinate effectively, because of the protection afforded bacteria by the solid material and the greater organic demand for chlorine. Higher residuals of chlorine should therefore be maintained in the amount of about one-half part per million in emergency supplies being pumped at fairly uniform rates. Where pumping is irregular and for brief emergencies, the non-potable supply should

be so heavily dosed that chlorine will be obviously present wherever such water is withdrawn for drinking and domestic uses.

In connection with disinfecting emergency surface supplies, it is important that points of suction or intake be located as remotely as possible from points of concentrated pollution, such as sewage outfalls, storm drains, and industrial drainage and heavy surface run off. Avoidance of such pollution both reduces the hazard and makes chlorination less difficult.

Surface waters particularly may be receiving industrial wastes, toxic chemical or organic compounds, which would render the water useless for all except fire-fighting purposes. Also heavy growths of algae may develop at certain seasons, thus clogging pumps and making the water too offensive for domestic use. The latter condition in a pond or lake, the emergency use of which may be expected, warrants routine treatment by copper sulphate to maintain the supply in a physically usable condition.

The local health authority may be expected to give prior approval to the use of any such emergency supply and should, by sampling and sanitary survey, determine the general condition of each such supply and the degree of pollution normally present. When such a supply is in use, it is, of course, the responsibility of the health authority to check the measures of disinfection, assist the local water supply officials in residual chlorine determinations and secure and examine water samples both from the emergency source and from the distribution system. It is also a joint responsibility of water supply and health officials to issue adequate and insistent warnings to the public regarding the condition of the supply and to arrange for emergency drinking water sources, independent of the public supply system, where necessary.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 12

To be reproduced locally for distribution to Class Members

Emergency Sources of Water Supply

Public water systems on the average are usually designed to provide 100 gallons of water per capita per day. Either pumping rates or elevated storage, or a combination of both, must be provided to meet peak demands at certain hours of the day.

The war may produce abnormal emergencies, and we can expect abnormal demands on a water system as a result of bombing, fires and sabotage. In order to meet these extreme conditions, plans for emergency water supplies should be made in advance. Such planning entails the utmost of cooperation between water supply and fire-fighting authorities.

Emergency water supplies may be secured, if locally available, from the following sources:

1. Adjacent public water supply systems, through prepared connections between the systems or by temporary connections such as hose lines and fire pumpers.
2. Private supplies such as wells and storage tanks, used for industrial purposes, air-cooling and refrigeration, estate supplies, swimming pools.
3. Fire wells or cisterns—prepared emergency supplies not otherwise used.
4. Ponds, lakes, streams, tidal water-fronts, swimming pools.

Emergency water supplies must conform to certain conditions in order to be useful in supplementary public supplies. These conditions are as follows:

A Accessibility
B Adequate volume, pressure, and rate of flow
C Power and pumping facilities, fixed or temporary
D Connections by pipe or hose
E Means of disinfection, if non-potable supply is delivered to drinking water system
F Freedom from toxic chemicals, silt or clogging growths

Public Supply Inter-Connections.

Another public system makes the most satisfactory reserve source of supply for a number of reasons. Such emergency connections are most practical in urban districts where 2 or more public systems are closely adjoining. It is possible, too, for one system to have connections with a number of adjoining ones.

When systems are some distance apart the cost of inter-connecting may be considerable and must be weighed against the cost and value of other means of reinforcing a particular supply.

Emergency connections should be made between supply mains whenever possible and of the largest size possible. One or two gate valves should be used for controlling the flow, and meters should not be necessary, since the amount of flow can be estimated for purposes of payment, or return of equivalent volumes.

Adjacent distribution systems usually are under different pressures. A higher system can always supply a lower one, and if the lower system is under a pressure sufficient to compensate for the difference in elevation, it may furnish water to the higher system under normal operating conditions. Booster pumps may be needed, however, when the differences in elevation are appreciable. Emergency use of inter-connections, however, are of most value when one system subject to rupture by bombing would be under very low or zero pressure so that it would be feasible to supply water during an emergency.

The use of fire hose in place of actual connections has a number of disadvantages. Open hose connections offer an avenue of contamination. Friction losses in fire hose are extremely high. No ordinary arrangement of multiple hose lines can equal the delivery of water through a proper pipe connection.

Hose used for emergency water supply should be used for no other purpose.

Private Supplies.

Of all private water supplies, probably the most adaptable are the large industrial sources which are most likely to be found at a large factory requiring large volumes in manufacturing processes. Ice plants, store and office and theater buildings, institutions, schools, private estates, golf courses, swimming pools, etc., provide smaller. but none the less effective supplies.

Fire Wells and Cisterns.

Fire wells have been installed in some communities at strategic locations in areas where shallow ground water is readily available. Large underground cisterns have been constructed in some communities as storage reservoirs for fire fighting.

Surface Waters as Emergency Sources.

Even though natural surface waters such as lakes, rivers, ponds, etc., provide excellent emergency sources of water supply for fire fighting, they cannot be used as emergency sources of public water supply used for potable purposes unless emergency chlorination is provided. Fire pumpers or other portable pumps may be used to force water from a lake, river or pond into a water distribution system through a hydrant or through a direct main connection, provisions being made to disinfect the water so pumped. In the absence of effective treatment facilities, fire pumpers taking suction from a non-potable supply should discharge exclusively through fire hose leading directly to nozzles, inasmuch as non-potable water should not be forced into public distribution systems.

The sanitary conditions surrounding an emergency source of public water supply should be determined and arrangements made for prompt use of the source without menace to the public health. Contact should be made with the local health officer and through him with the State Commissioner of Health, so that appropriate action may be taken to protect the public health during an emergency to the public water supply.

General Consideration.

Accessibility is a prime condition in relation to emergency water supply. The value of an emergency supply, assuming that it is potable, lies in its volume, rate of flow and pressure in relation to the public supply.

Independent sources of electric power are particularly desirable when the public supply of power has failed.

The disinfection of a non-potable supply is essential and requires advance planning in the assembly of necessary chlorination or disinfection apparatus. Points of suction or intake should be located as remotely as possible from concentrated pollution, such as sewer outfalls, storm drains, etc. Surface water may be contaminated by industrial waste or toxic chemical compounds which would render the water useless for all but fire fighting purposes.

CLASS LESSON NO. XIII

Plans of Action in Case of Emergencies

SYLLABUS FOR CLASS TRAINING SESSION NO. 13

2 Hours

Subject. *Plans of action in case of emergency.*

Instructor. Each local water department head should give this lesson separately to all of his own auxiliaries.

Scope. *First hour:* Lecture and explanation of the plans which have been formulated for emergency action.

Second hour: Discussion and "true-false" examination based on all lessons of the course.

Reference Text for Lesson.

The basis of most successful undertakings is the foresight or vision of the man responsible for such achievements. This foresight or vision is not idle dreaming or panicky worry but a resolute and systematic planning for probable contingencies, followed by the organization of available skills and materials in accordance with the ideas of the planner. One of the principal differences between the savage, howling himself into an emotional frenzy before going into combat, and the 20th Century soldier, preparing for battle, is that the savage had very limited means and ability for planning and preparing for war, while the modern soldier is carefully trained and equipped for the task at hand. We are fortunate in this country in having men like yourselves who do have vision and who are anxious and willing to become part of the national team working for the defense of our homes and the defeat of the powers of tyranny.

Recognizing the possible development of wartime emergencies, the city of Progressville has made definite plans and provisions to cope with such disasters. It is the purpose of this lecture to inform you of these plans so that each man may do his duty, when the crisis arrives, with a minimum of delay and confusion. In many ways, our department, including our auxiliaries, must function during an emergency like a well trained and fully equipped fire department responding to a fire alarm. We must act quickly but in a careful, disciplined manner in accordance with a thoughtfully drafted plan.

It should be remembered that much of the money invested in our water supply systems has been spent in preparation for

emergencies, particularly for fighting and controlling fires. The fundamental design and construction of the water system includes provision for reserve storage of water at the distribution reservoirs, as well as at our main source of supply. These reservoirs will be kept as full as possible during the war. Through the grid arrangement of our distribution system, water can follow several paths to points where needed. Our principal supply mains, chlorination plants and pumping stations are provided in duplicate, and recently we have connected our distribution system to those of our neighboring communities. Despite the factors of safety in our water supply system and its flexibility of operation, it is essential that there be competent, well trained water work personnel and auxiliaries to meet emergencies, particularly wartime emergencies, because it is impossible to know in advance the havoc which may be caused by a disaster such as a bombing. It must be realized that it is not practical or possible to prepare for the worst of wartime attacks, but a well prepared corps of auxiliaries can be invaluable in limiting damage and in restoring service.

As all civilian protection units operate under the supervision of the Director of Civilian Protection through the Control Center, our emergency repair forces work under orders issued from that point. John Doe, my assistant, reports, when called on an alert, to the Control Center and serves as advisor to the utilities officer, Howard Smith, and will maintain contact with our headquarters. My official station is at our main office where instructions will be issued for carrying on the work.

Our six emergency repair crews will each report promptly to their designated stations when the air raid siren sounds. Crew No. 1 under Edward Anders will report to me at headquarters; Crew No. 2 under Roy Hughes will go to the city tool house on East Pine Street; Crew No. 3, Louis Korona in charge, will assemble at the Fourth Ward Fire House on Lincoln Street; Frank Lanes' crew, Crew No. 4, will gather at the plant of the Jones Bros. Leather Company; Crew No. 5, under the leadership of Michael Seabury, will meet at the Fifth Ward Firehouse on Franklin Street; and Crew No. 6, with Harold Shaver in charge, will report at Shaver's residence on Littauer Place.

As soon as the control center receives information of damage to the water supply system, the notice will be relayed to the water department headquarters. Instructions will be telephoned to the nearest crew to shut off the damaged main. When the main has been shut off, the foreman will report to water works headquarters

and information will be forwarded to the control center, then through them to the fire department that the main is out of service. *It is our responsibility to quickly shut off breaks.* Air raid wardens and other civilian protection personnel have definite instructions not to touch water supply valves and controls.

Before operating any valve, special care should be used to determine whether the valve opens to the right or left and the size of the valve. Knowing the size of the valve and the approximate number of turns required for operation, the number of turns should be counted to determine whether or not the valve is operating properly.

When the break or breaks have been shut off, Foreman Edward Anders, who is in charge of distribution system maintenance, will make a survey of the damage done and will assist me in planning the repairs. The men who will be needed will be notified. The materials, supplies and equipment necessary will be prepared for dispatch to the scene of the break.

After the all clear is sounded and the problems confronting the department are analyzed, those men who will not be needed will be excused. As soon as plans for repairs have been completed and instructions given to those who will make the repairs, they will be excused until daybreak, when they will report ready for duty.

We realize that some of us may be incapacitated by injury or illness and may not be able to serve when needed. In view of this, each key man has two understudies who are ready to replace him if he should become a casualty. To ascertain the ability of these substitutes, it is planned to ask them to serve in place of their principals during some of our preparatory drills.

At the time of the emergency, speedy effective action will mark the well prepared water works crew. Each foreman has been supplied with a plan of the distribution system and a valve book for his district. He is expected to maintain careful custody of these records, so as to prevent their falling into the hands of those not entitled to them. But merely keeping the records is not enough. Each foreman and his understudies should study his district carefully. Each street should be traversed and each valve located, so there will be no delay in finding and operating it when the time of need comes.

We consider our equipment and supplies reasonably adequate for ordinary emergencies but realize we may have to call on neighboring communities if we are severely damaged.

Sets of emergency supplies recommended by the American Society of Civil Engineers are kept at waterworks headquarters, the city

tool house, and at the water purification plant. It is the responsibility of Mr. Anders of our department to see that the tools and supplies in these sets are complete and in good condition. Supplies from the three points of storage will be transported to the repair crews as needed.

In the event of a major disaster, it will be necessary to transport drinking water to sections otherwise deprived of a safe supply of potable water. A separate three man squad known as the Mobile Drinking Water Squad is prepared to deliver this supply. The street flushing truck of the department of public works will be used to distribute this supply as needed.

Another complication which must be considered is attack by poison gas. I have invited Mr. John Miller, Chief of Decontamination Squads to instruct us in precautions against poison gas, at this time.

On behalf of the Water Department, I wish to express my appreciation to you for volunteering your services and for your efforts in preparation for action. I trust that each one of you will continue to be alert and ready so that if disaster comes, there will be no regret that we were not fully prepared.

NOTE: In giving this lesson the local water superintendent should go very thoroughly into all details of his own particular plans for handling severe emergency situations of various kinds so that each auxiliary will thoroughly understand his own particular duties and responsibilities.

SANITATION AND WATER SERVICE TRAINING PROGRAM

Home Study Outline for Lesson No. 13

To be reproduced locally for distribution to Class Members

Plans of Action in Case of Emergencies

Systematic planning and preparation for all possible emergencies and contingencies offer the best means of protection to a community in time of war. With such planning and preparation water department personnel and auxiliaries can act with the smoothness of a well-oiled machine when water supply emergencies arise.

One very important point in being prepared is that all water reservoirs should be kept as full as possible for the duration of the war. There should be inter-connection of adjacent water systems when possible. Adequate supplies of equipment for repair and emergency chlorination should be on hand at all times. A well-trained Corps of Auxiliaries and Volunteers is indispensable in meeting an emergency resulting from bombing or sabotage.

Emergency repair crews will operate under the supervision of an authorized Control Center. There may be minor variations in the procedure, but all information pertaining to damage to a water supply system will be properly relayed in one or two stages to repair crews and auxiliaries which are assembled nearest the point of damage. Only trained and authorized auxiliaries, not air raid wardens or other civilian protection personnel, should be permitted to touch water supply valves and controls.

Arrangements should be made for at least one understudy to each key man in an emergency repair crew. With the aid of records and maps, crew foremen and their understudies should survey every street in their district and study location of valves.

A major disaster may deprive an entire community of potable water. In this event, provision will have to be made to transport drinking water to points where it is needed. Tank trucks, street flushing trucks and related equipment will have to be used for this purpose. Crews should be trained in the disinfection of such equipment.

DETAILED SYLLABI FOR FIELD TRAINING SESSIONS

SYLLABUS FOR FIELD TRAINING SESSION NO. 1
2 Hours

Subject: Operation of a fire pumper.

Instructor: Demonstration preferably should be made to a combined group of auxiliaries from all villages and towns of the county. A local fire chief should be asked to provide the demonstration.

Scope: *Two-hour demonstration* of the hookup of a fire pumper, explanation of its operation, and demonstration of fire streams. General method of operation of the fire department should also be explained.

SYLLABUS FOR FIELD TRAINING SESSION NO. 2
2 Hours

Subject: Inspection of a water purification plant.

Instructor: Superintendent of the plant. Should be made by a combined group of auxiliaries.

Scope: *Two-hour tour of inspection,* with explanation of processes and operation by the superintendent.

SYLLABUS FOR FIELD TRAINING SESSION NO. 3
2 Hours

Subject: Inspection and operation of repair and maintenance equipment.

Instructor: Each water department head should conduct his own auxiliaries on tour of inspection.

Scope: *Two-hour inspection* of all repair tools and other equipment, with instruction as to their use, withdrawal from storerooms, etc. Operation of equipment should be demonstrated and auxiliaries given some practice.

SYLLABUS FOR FIELD TRAINING SESSION NO. 4
2 Hours

Subject: Practice in chlorine demand, residual chlorine tests, and batch disinfection of water.

Instructor: Demonstration should be for a combined group of auxiliaries. An experienced water plant operator or chemist should serve as instructor.

Scope: *Two-hour practice* by each student in making the various tests.

SYLLABUS FOR FIELD TRAINING SESSION NO. 5
2 Hours

Subject: Practice in making repairs or operation of repair equipment.

Instructor: Each water department head should provide practice periods for his own auxiliaries.

Scope: *Two hours' practice* in performing various repair operations in a shop or on a demonstration setup.

SYLLABUS FOR FIELD TRAINING SESSION NO. 6
2 Hours

Subject: Drill under simulated conditions of an emergency.

Instructor: Each local water department head should provide drill periods for his auxiliaries.

Scope: *Two hours' drill under* a simulated emergency. Drill should include the receipt of reports of water incidents, simulated shutoff of water in the affected sections, assembly of repair equipment on the job which will be needed for repairs, discussion of how the job is to be done, estimate of time required to complete it, review of the setups for emergency pumping stations and chlorination plants, water delivery service, etc. From time to time this field lesson should be repeated under different simulated conditions.

APPENDIX

Supplementary Reading

Suggested references for supplementary reading in connection with Training Schools for Water Works Auxiliaries.

Subject: *Emergency Repair of Mains,* (Lessons Nos. 5, 6, 7).

References: *Repair of War Damage*—Johns Manville, New York, N. Y.

Symposium on Equipment Available for Emergency Repairs & Distribution Systems. Nelson Thompson, Clinton Inglee, Rossiter, Scott, Carson—A. W. W. A. Col. 33, No. 10, Oct. 1941.

Restoring Water Service in Bomb-Broken Mains.—Public Works —Apr. 1941, P. 16.

Operation of Distribution Systems under Bombing Conditions, by Richard Bennett. Water Works & Sewerage, p. 261, Vol. 89, No. 6, June 1942.

Subject: *Emergency Disinfection of Mains & Water Works Structures,* (Lesson No. 8).

References: *Pollution Prevention in Distribution Systems in Britain*—E. G. B. Gledhill & McCanlis—A. W. W. A. 33:1116 (1941).

Chlorination Equipment Available for Emergency Use, by Harry A. Faber—A. W. W. A. Vol. 33, No. 8, Aug. 1941.

Subject: *Mains & Water Works Structures,* (Lesson Nos. 5, 6, 7, 8).

References: *Bombing Danger to Tanks Shown by English Practice,* by Eric Hardy—F. Z. S., Water Works Engineering Feb. 25, 1942.

Wartime Water Works Maintenance in Britain, by A. Corrington Wildsmith, A. W. W. A. Vol. 34, No. 2, Feb. 1942, p. 179–188.

Should Bombs Come—Water Works Engineering—Mar. 25, 1942.

Subject: *Pump,* (Lesson No. 11).

References: *Centrifugal Pumps,* by H. E. Beckwith. Water Works & Salvage—June 1942.

Maintaining Pumping Equipment—Water Works Engineering—p. 784—July 1, 1942.

Operating Centrifugal Pumps—Water Works Engineering—p. 358—Apr. 8, 1942.

Equipment for Pumping Station—Water Works Engineering—p. 245—Mar. 11, 1942.

Subject: *Chlorination,* (Lesson 4, 5, 10).

References: Bulletin 21—*Protection and Chlorination of Public Water Supplies*—N. Y. State Department of Health, Albany, N. Y.

Bulletin 33—*Tests for Residual Chlorine and Ammonia*—N. Y. State Department of Health, Albany, N. Y.

Sterilizing Water Mains— Wallace & Tiernan, Inc., Newark, N. J.

Technical Publications 228, 178, 235 and 408—Wallace & Tiernan, Inc., Newark, N. J. (Also installation diagrams and other literature published by above company).

Subject: *General.*

References: *Water Supply Facilities & National Defense,* by John Edgar Hoover, Nov. 1941, Vol. 33, No. 11.

Water Supply Protection in U. S. Coastal States, Water Works Engineering, Jan. 28, 1942.

Protection and Maintenance of Public Water Supplies Under War Conditions. Sanitary Engineering Bulletin No. 1, U. S. Office of Civilian Defense, Washington, D. C.

Gate Valves—Their Care and Maintenance—Roger W. Estey—Water Works & Sewerage, June, 1942.

Hydrant Maintenance, by E. T. Cranch—Water Works & Sewerage—June 1942.

List of Training Films

These films may be obtained, rental free, by request from the New York State War Council, Office of War Training, 353 Broadway, Albany, N. Y. Orders should be mailed at least **two weeks in advance** of scheduled showing date.

"Behind the Water Tap" *Time: 34 minutes, 16 mm. Silent.* Produced by Industrial Chemical Sales. This colored film is educational in nature, giving a picture of methods of water purification necessary to deliver pure and palatable water to consumers.

"Health and the Cycle of Water" *Time: 28 minutes, 16 mm. Sound.*
Produced by Burton Holmes for the Cast Iron Pipe Research Association. This film deals in detail with the process of water purification and the use of cast iron pipe in purifying water.

"The Ominous Arms Case" *Time: 25 minutes, 16 mm. Sound.* Produced by Pure Water Film, Inc. This film deals in detail with the important plumbing problem of back siphonage.

"Portable Water Purification—Unit Model 1942" *Time: 27 minutes, 16 mm. Sound.*
Produced by Pure Water Film, Inc. Illustrates the purification of polluted water through the utilization of portable equipment.

"Emergency Water Main Repairs" (In preparation)

"Operation of a Fire Pumper" (In preparation)

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....

Town or City

NOTE TO BORROWER:

Films will always be sent to reach you on date requested, if available, but in order to make sure that you will receive films when you want to use them, *please state second choice dates.* Orders should reach the Office of War Training about two weeks in advance. Orders should be cleared through the War Training Committee of your local War Council.

Date of Showing		Title of Films
1st Choice	2nd Choice	

PLEASE CHECK which instruction you wish us to follow, if the films you request are not available for either of the dates specified above:

- ☐ Substitute other films
- ☐ Substitute other dates
- ☐ Make no substitutes

....

Date This Order Was Mailed Signature

....

Position

*Starting and Conducting Training Sessions

Starting the Training Session.

The Auxiliary instructor should conduct his class on the assumption that his "pupils" are all adults.

Their ages may vary over a wide range.

Their educational backgrounds may also vary over a wide range.

But all are enrolled civilian volunteers because they wish to contribute their services to aid their neighbors, their community and their country in the war program. Their sincerity and patriotism and self-sacrifice link them to one another in a common objective.

Certain procedures for the conduct of the Sanitation and Water Works Auxiliary Training Course are suggested. These suggestions are offered in the light of experience in dealing with similar groups :

1) Start and stop the training session on the scheduled time.
2) Deliberately create an atmosphere of informality.
3) Introduce yourself and the individual Auxiliaries to each other at the first meeting. Have each stand, give his full name, his address, and perhaps his occupation.
4) Employ good housekeeping in your classroom. Insist on a room with adequate ventilation and lighting, or take personal steps to provide your room with the best ventilation and lighting possible. If, as will probably be the case, public school classrooms are used for Auxiliary training, there will probably be good ventilation and lighting.
5) Allow the members of the group to take a five-minute recess during the instructional period.
6) Do not underestimate the intelligence of the members of your group. They may be as skillful in their own vocation as you are in yours.
7) Advise the group that a short final examination will be given during the last half of the final session.
8) Explain that the University of the State of New York, State Education Department, Bureau of Public Service Training, will issue Certificates of Attendance to those successfully completing the course.
9) Always find an opportunity during the training session to emphasize the important part the Water Works Auxiliary plays in the total Civilian Protection Services of his community.

* Adapted from *"Instructor-Training Manual"* published for the New York State War Council by the Office of War Training.

Suggested Check List of Classroom Equipment.

——Blackboard——————————————————
——Chalk——————————————————
——Erasers——————————————————
——Pencils——————————————————
——Scratch pads——————————————————
——Examination——————————————————
——Examination paper——————————————————
——Attendance slips——————————————————
——Application blanks——————————————————
——Films*——————————————————
——Screen——————————————————
——Dark shades——————————————————
——Film Projectors——————————————————
    ——Silent——————————————————
    ——Sound——————————————————
——Projector operator——————————————————
——American flag——————————————————
——Display board——————————————————
——Chairs——————————————————
——Table——————————————————
——Adequate lighting——————————————————
——Adequate ventilation——————————————————
——Access to lavatories——————————————————
——Electric leads and sockets——————————————————
——Instructor's Manual——————————————————
——Other instructional materials——————————————————
——Charts, graphs, posters——————————————————
——Demonstration materials——————————————————

* Films are loaned by the State Office of War Training, 353 Broadway, Albany, N. Y. They should be requested at least two weeks in advance of the date on which they are to be shown.

Preparing and Presenting Work for Each Class.

A class lesson is the cooperative effort of both instructor and pupil. There are four steps to be considered in the kind of lesson the instructor will give. These are:

1) Preparation.
2) Presentation.
3) Application.
4) Testing.

In planning a lesson the instructor should bear in mind the relation of these four steps to:

Objectives to be reached.

Techniques and activities that are to be used to achieve these objectives.

Materials that are to be used to achieve these objectives.

Tests of achievement.

1) PREPARATION

The instructor must realize that the primary purpose in the *preparation* of the lesson is to obtain the *interest, attention* and the *desire to learn* on the part of the pupil.

A) **Characteristics of the Training Period.** Before deciding which one of these methods of instruction to use, the Instructor must consider the following characteristics of the training situation.

The training situation must represent a single unit of instruction.

The training situation must have a new element.

The training situation must be reasonable in scope.

The training situation must be adapted to the needs of the trainee.

- a) Every new experience is interpreted by the learner through his previous experience, hence the new skills or knowledge of a Water Works Auxiliary's duties must be related to, or associated with a part of the learner's former experience.
- b) Each new experience of the training program should be consistent with the learner's ability, proficiency and interests.

The training situation should require a standard of achievement that is measurable.

- a) The Auxiliary should be informed of the standard of achievement to be expected.
- b) The measures for checking the standard of achievement and their application should be clearly understood by the instructor.

B) **Lesson Planning.** When all these aspects of the training situation have been considered, the instructor should plan:

To determine the past experience of the trainee
To determine the interest of the learner in the job
To create interest in the trainee to do the job
To ascertain, as far as possible, the intelligence of the learner
To estimate the amount of instruction required
To develop the proper attitude in the learner

The consideration of these elements of the training situation must then be followed by the selection of the proper materials, tools, visual aids, etc. required for the lesson. The means that the instructor plans to use to develop the proper attitude on the part of the trainee, and the method for connecting the new element to be learned with the past experience of the learner, must be planned before the presentation of the lesson.

The content of the Sanitation and Water Works Auxiliary Training Course and the number of lessons required to teach that content are indicated in this Instructor's Manual.

Prepared lessons, when carefully planned and executed, usually reach the objective desired. Unplanned lessons invariably take the instructor and the learner off on a tangent and fail to reach their objective. The suggested sequence to be followed in preparing any lesson will help to make the most effective use of the instruction period:

Analyze the Instruction To Be Given For:

a) Skills
b) Knowledge
c) Equipment

Prepare the Lesson Listing these Data in Sequence.

Determine Methods You Will Employ in Presenting Material to Class.

a) Explanation (Lecture, Discussion, etc.)
b) Demonstration (If Required)
c) Equipment and Aids

Use this Plan for Teaching the Lesson

2) **PRESENTATION**

The presentation of the lesson is so closely associated with the preparation step that there is no attempt here to separate the two steps. Certain guides to good presentation should be observed by all instructors.

Methods of Presentation.

A) **Lecture Method.**

a) *Disadvantages.* Maximum instructor participation and minimum student participation.

Does not encourage reflective thinking.

Results cannot be immediately checked.

Does not involve response on part of the learner.

No means of determining actual interest on part of the group.

Usually deductive.

b) *Advantages.* Economizes time of class.

Can be used with large groups.

A means of epitomizing information not otherwise easily available.

Easily supplemented with illustrative material and demonstration.

Instructor is sometimes best equipped to gather, classify and interpret information.

c) *Important Lecture Points.* When a lecture is given the lecturer should observe these points:

Use language the learner understands.

Use effective introductions to sentences and phrases.

The length of the lecture must be gauged by these factors:

The mental level and maturity of the pupil.

The complexity of the lesson to be given.

The ability of the learner to maintain interest and attention.

"Make the lecture as short as possible" is sound practice. When possible, alternate with application of the thing discussed. It is sound practice to give small units of instruction followed by small units of application. This avoids any long lapse between discussion and applications.

The lecture must meet the needs of all individuals in the class.

B) **The Group Discussion or Conference Method.** This is the classroom procedure which makes it possible for both instructor and pupil to participate.

a) *Disadvantages.* All members of the group may not participate.

Time may be wasted through too much talking.

Difficulties may be experienced in keeping the class on the subject.

b) *Advantages.* Uses the natural desire for self expression.

Broadens thought by presenting many sides of the question.

Clarifies concepts.

Encourages careful preparation.

Teaches tolerance and respect.

C) **The Demonstration.** The demonstration is the manipulative performance by the instructor or outside expert in the presence of the pupils for the purposes of securing correct imitations by them or to give clear understanding of facts or priniciples.

a) *Disadvantage.* Student is usually an observer. Hence the demonstration must be followed by application.

b) *Advantages.* One of the most effective methods of instruction.

Sets good procedure for student to imitate.

Sets a standard of attainment.

Used with explanation, the demonstration uses both hearing and seeing, and often employs other senses.

Avoids trial and error method on part of student.

Provides instruction not possible to give verbally.

c) *Important Demonstration Points.* When a demonstration is to be given, the instructor or expert making the demonstration should realize that the good demonstration is one of the best methods of instruction. This is especially true in instruction for civilian defense. The five principal points to observe in making a demonstration are:

Arrange in advance all material and equipment required for the demonstration.

The demonstration must be clearly visible.

It must be performed slowly enough to be grasped by the learner.

It must be broken down into elementary steps.

It must be accompanied by a verbal explanation.

The demonstration should be tested in advance if necessary. All possible distractions should be removed before the demonstration. Short demonstrations are better than long ones.

d) *Improving the Demonstration.* The following suggestions for improving the demonstration are offered in the light of the experience of many teachers using this method:

It may be advisable to provide one demonstration showing the speed at which the actual job should be done. This can then be followed by a slower performance accompanied by explanation and discussion.

Explain each step as you perform it, telling why as well as how.

Be sure that everyone can see. Control all the factors involved.

Supplement your demonstration, when necessary, with pictures, charts, diagrams, models and any other necessary aids. Do not hesitate to make full use of the blackboard.

Question the learners as the demonstration progresses. Each step must be understood by all before the next step is taken up.

The learners should see the demonstration from the angle at which they will see it when they do the job themselves.

Speak clearly and distinctly.

Have only one activity going on at a time.

If the learners are standing around you, see that they are grouped according to height and in a large enough circle so that crowding is avoided.

Do not lose the techniques involved in a normal performance when slowing down the performance below normal.

The intelligent application of the elements of good instructional procedure necessary to the preparation and presentation of parts of the lesson will insure that the learner will be well guided to perform the skill and acquire the knowledge necessary to make the application of that which the instructor desired to teach him.

D) **The Group Performance Method.** This method is a combination of the lecture, group discussion and demonstration method. It includes explanation, demonstration by the instructor, imitation by the members of the group and the immediate correction of errors. This is an ideal situation in which the advantages of the other methods of instruction may be employed for the instruction of the whole group. Careful organization of the plan for this type of instruction must be prepared lest the good results possible be lost through bad arrangement.

E) **The Coach-Pupil Method.** A highly successful method of instruction is the *coach-pupil* method. Pupils may be paired off in this teaching situation and interchanged in their respective positions so that each is on the receiving end and each on the giving end of the instruction involved. It is necessary that adequate supervision be provided for this kind of instruction. This method of instruction, while highly successful, should be preceded by one of the other methods before it is used.

a) *Disadvantages.* Requires an adequate supervising staff. In general the group taught should provide this supervision.

Cannot be used initially.

b) *Advantages.* Insures the participation of each pupil.

Provides opportunities for an immediate check of the instruction.

Provides opportunity for an immediate correction of errors.

F) **Visual Aids.** The importance of appropriate kinds of visual aids in all learning situations involved in the methods of instruction suggested cannot be over-emphasized. Illustrations of the methods

discussed here are shown in the film, *"Military Training,"* produced by the U. S. Army Signal Corps, in a highly objective way.

Visual aids are among the most important supplementary devices for the improvement of learning that we have. It is necessary for the prospective instructor to realize that these aids are a *supplement to instruction* and *not a substitute for instruction.*

In general these aids may be utilized for three principal purposes. These are:

To stimulate or arouse interest and enthusiasm, thus creating a desire for further information which may be provided by the instructor through discussion, lecture and demonstration or through recommended further reading.

To illustrate a point or *series of points* raised by the instructor, thus serving to clarify or simplify the points.

For review and summary.

The instructor should observe these two procedures when using visual aids:

The instructor should preview and analyse all visual aids prior to their use in the classroom. This must be done if these aids are to be used intelligently.

Discussion and check-up should always follow the use of visual aids. This will insure that the objectives which the instructor hoped to realize through the use of these aids really were accomplished.

Silent Motion Pictures.

The motion picture is a series of still pictures, which, when projected rapidly, produce the illusion of motion.

a) *Disadvantages.* Detailed study is not possible unless the projector is equipped with a screening device to cut the light on a single frame when the projector is stopped.

Difficult to measure interest and attention during time the film is being shown.

b) *Advantages.* Particularly good for showing change, growth and development, or processes.

Shows the whole process. Motion pictures may be supplemented by other aids for detailed analysis.

Can reproduce action too slow or too fast for the human eye to perceive.

May, when silent, be accompanied by teacher explanation, or commentary.

Makes available material that cannot be brought into the classroom otherwise.

Sound Motion Pictures.

Sound motion pictures have the same advantages and disadvantages that silent films have. Sound motion pictures, generally speaking, preclude comment or discussions by the teacher during the showing of the film. This weakness, however, is overcome by the fact that the commentary or explanation on the film's sound track is often more skillfully done than it would be by the instructor discussing the same picture and using a silent film.

If, however, the instructor does not wish to use the commentary on the sound track and prefers to comment himself, he can eliminate the sound features of his equipment. He can then use a matched microphone and the public address or power pack part of the projector to provide his own commentary.

Lantern Slides.

A pictorial or diagrammatic representation on a glass plate is called a slide. It may be made from a photograph or made by an instructor using colored or india inks, crayon or pencil.

a) *Disadvantages.* More expensive than film strips.

Easily broken.

(Kodachromes 2 x 2 size have the same advantages that slides have, plus the added attraction of color. The pictures, however, are smaller.)

b) *Advantages.* May be used for detailed study.

Permits flexibility in that it allows the user to arrange his material in any sequence he desires. It is not necessary or desirable to use all the slides available in the presentation of a single lesson. In fact the use of a few slides to drive home vital points is considered the best practice.

Permits discussion by instructor.

May be made by the instructor as needed.

Film Strips.

A film strip is a series of silent 35 mm. frames, each of which may be projected separately and examined in detail.

a) *Disadvantage.* Lacks flexibility of the lantern slide.

b) *Advantages.* Cheaper than lantern slides.

Permits detailed study.

Permits discussion by instructor.

Charts and Diagrams.

A chart or diagram is a simple method for breaking down complex data into simple elements. It may be pictorial or diagrammatic.

Advantages. Data may be easily represented.

Relationships may be clearly protrayed.

Charts and diagrams permit detailed study.

Assists the learner in remembering important points of presentation.

3) APPLICATION OF NEW KNOWLEDGE

The instructor should provide the opportunity at the earliest possible moment for the application by the learner of the new knowledge he has been taught.

A) **Good Instructional Procedures.** Good instructional procedures during the application step will enable the learner to make the most of the opportunity to apply the new skill. The following suggestions are made with respect to the instructor's activities during this step:

The instructor should let the learner do the job.

The instructor should give instructions only when necessary and these should be clear and timely.

The learner should show the complete demonstration.

The learner should not be confused by too close supervision.

The learner should be prevented from making mistakes if possible.

It may be advisable for the learner to make a sketch or diagram to explain the methods before making the application.

4) TESTING LEARNERS

The test itself is a means to an end. It is the method by which the instructor can gauge the degree to which the learner has acquired skill and knowledge. It quickly shows whether remedial instruction is necessary and it usually will indicate what phases of the instruction processes need to be improved. The instructor should appreciate these two uses he can make of test results, as well as use the test for rating the learner.

One final word concerning the learner's achievement. It is a recognized fact that most of the learners in the civilian defense classes contemplated in this instructional manual are individuals of average or better intelligence. There may be an individual member of the class who, in spite of good instruction and individual help, fails to master his assignment. Since the welfare of the community comes first and the prestige of the individual second it shall be the duty of the instructor to handle this situation with intelligent action.

A) **Rating the Learner—Job Performance.** The rating of the performance of the learner should take into consideration these points:

a) *Time of rating.* Rating should be made immediately upon completion of the lesson. The details are fresh in the instructor's mind and the appraisal is more accurate and objective.

b) *The rating scheme should be simple.* Performance should be rated so that all concerned are aware of the meaning of the rating. It is suggested that only three ratings be used: Excellent, Satisfactory, and Unsatisfactory.

c) The rating of the learner should become a part of the permanent record.

A rating must be reliable and must not be based on "effort". The record must contain the actual evidence of the learner's performance.

B) **Rating the Learner—Personal Characteristics.** The rating of the performance of the learner should be supplemented by a rating of the personal characteristics that are important to defense service

The rating of the personal characteristics of the learner should not be made until the instructor has ample time to become acquainted with the learner. It is suggested that this rating be made at about the middle of the training course and at the end of the course. These characteristics and the evidence of the learner's possession of these personal traits may be easily checked through a rating chart similar to the one shown.

Relative degrees of rating in these personal characteristics may be indicated by the position of the check mark. For instance, a person might be rated just above the average by placing a check mark at the right hand side of the column marked "high".

Characteristics	*Rating*		
	High	*Average*	*Low*
Interest in work........................			
Cooperation with others..................			
Dependability...........................			
Ability to direct others................			
Personal courage........................			
Initiative..............................			

C) **Evaluating Instructor's Performance.** It is valuable for the prospective instructor to have his initial teaching attempts checked closely by a supervisor using a check list. This list would include the following items:

Had the instructor determined just what he was going to teach?

Was there any evidence of advance planning and preparation?

Did the instructor show the ability to set the learner at ease and hold his interest?

Did he attempt to give too much instruction in one lesson?

Did he put the lesson over point by point and make sure that each point was clearly understood before proceeding?

Did the instructor cover all essential points?

Did he use the first three teaching steps?

Did he make sure the lesson was clearly understood by asking the proper questions to check instruction?

Did he use methods in each step suited to the lesson and the learner?

Did the instructor hold to his subject or did he get off the track?

Did the learner do the job unaided and did he know the essential facts when the instruction was completed?

INSTRUCTOR'S OUTLINE FOR PREPARING A LESSON

1) Standard heading, identification and classification of lesson
2) Preparatory plans for
   - A) Instructor
     - 1) Equipment
     - 2) Visual Aids
   - B) Learner
   - C) Assistants from class
3) Presentation plans
   - A) Skills to be taught in proper sequence by demonstration method
   - B) Knowledges to be taught in relation to skills in connection with demonstration or as separate topic by charts, descriptions, etc.
   - C) Visual aids used in their relation to steps in "A" and "B"
4) Application plans
5) Testing
6) Summary and discussion

SUMMARY SHEET — ANALYSIS OF TRAINING SUITABLE FOR THE CIVILIAN DEFENSE PROGRAM

Basic principles of helping others learn	*Procedures for helping others learn*	*Characteristics of training situations*	*Types of training situations*	*Degrees of preparation required*
Need must exist or be established.	*Preparation* (by instructor for learner).	Training situation should be *complete* in *itself*.	The *most desirable* training situations occur between:	*Preparation* should be *thorough but limited to specific skills* and *information.*
Interest must exist or be aroused.	*Presentation* (by instructor).	Training situation should contain a *new element.*	*Individual learner* and *instructor* (for specific skills and information).	*Preparation* must be *wider* in scope, more thorough, and *meet the need* of every *individual* in the group.
New skills and *information* must be *associated* with *old* ones.	*Application* by learner.	Should be *reasonable* in *scope.*	*Group* of *learners* and *instructor* (for more general skills and information).	*Preparation* must be very *thorough,* general in scope, and *meet* the *need* of *all* individuals who form the class.
Memory can best be developed when it is *preceded* by *understanding.*	*Testing* (by instructor of learner's work).	Depends upon the *needs of the job* and the *needs of* the *trainee.*	*The whole class* (for the general skills and information).	
Demonstrations and *explanations* must be expertly given.		Job must conform to standards which are measurable in terms of: *Method* *Quality* *Quantity.*		
Pupil learns by *doing.* Imitation.				
Instruction and application alternate between the instructor and learner.				

APPENDIX B

Facilities of State Office of War Training

The New York State War Council established the State Office of War Training on June 15, 1942. The Office is charged with providing coordinated direction and professional guidance to all State and local civilian war training activities, exclusive of vocational training for war industries. The Office is administered for the New York State War Council by the Chief of the Bureau of Public Service Training in the New York State Education Department who also organized and has administered the State War Council's State Fire Defense Training Program since June, 1941.

The State War Council established a centralized training office as one of its major steps in strengthening and reorganizing the State's war machinery under the State War Emergency Act.

The State Office of War Training is a cooperative service agency, rendering training services to the State Office of Civilian Protection, the State Office of Civilian Mobilization, and all other agencies executing the policies of the State War Council, and of the City and County War Councils.

The Office of War Training has been charged by the State War Council with the following broad functions:

1) To study and report, with recommendations for action, on all training proposals made to the State War Council from any source.

2) To plan and assist in the administration, coordination and supervision of public employee and civilian war training at the State level, and to render instructional assistance at the local level in cooperation with appropriate State and local agencies.

3) To act as a clearing house on administration and information for all public employee and civilian war training activities throughout the State.

4) To determine priorities of training programs, with initial emphasis on all training affecting protection of life and property.

5) To assist in the development of uniform instructional materials through curriculum laboratory committees composed of outstanding specialists and authorities in each field and area of training.

6) To assist in the further development and utilization of instructor training methods and materials.

7) To assist in developing, obtaining and utilizing visual instructional aids, such as films, slides, charts and other demonstration materials for civilian war instruction.

8) To prepare State War Council and Regents Public Service Training Certificates for issuance to civilians and public employees who successfully complete approved war training programs.

Local War Training Committees.

The Office of War Training operates on the local level through the War Training Committees appointed by the local War Councils at the request of the State War Plans Coordinator in his memorandum of June 23, 1942. The War Training Committees are appointed by the Chairmen of the local War Councils and they include the Director of Civilian Protection, the Chairman of Civilian War Services (Mobilization), Chairman of Volunteer Office, the local Superintendent of Schools, and three or four other persons with experience in training personnel for private or public agencies.

Functions of War Training Committee. The specific service functions of a local War Training Committee listed below should help an administrator of any war agency to make full use of such a committee:

A Serve as a training adviser to the Local War Council on all civilian war training problems and needs.

B Make a study of all civilian war training, except vocational training for war industries, which has taken place or is proposed in the area served by its War Council.

C Develop a local library of training materials and aids from all sources including agencies of the local War Council, the State Office of War Training and all other State War Council agencies, the U. S. Office of Civilian Defense, other local, State and Federal Departments of Government and private industrial, technical or professional groups.

D Develop a register of all available classrooms in public and private structures throughout the area which it serves.

E Arrange personal conferences with the head of every local War Council agency to obtain information on agency training activities and to acquaint the head of the agency with the organization and functions of the Local War Training Committee.

F Prepare, in collaboration with the Local Volunteer Office, for distribution to all Local War Council agencies and the public schools, a Directory of available local civilian war training courses. The Committee should make arrangements for regular publication of the contents of the Directory in local newspapers.

G Develop a panel of all available civilian war training instructors in the area served by the Committee.

H Collaborate with Local Volunteer Offices in arranging for New York State War Council Civilian War Training Certificates.

I Aid Local War Council agencies in developing and maintaining training records.

J Assist all Local War Council agencies in the continuous in-service training necessary to preserve the skills and morale of volunteer forces engaged in the war effort.

K Act as a service unit for all Local War Council agencies.

L Serve as a local representative for the services of the State Office of War Training in the following ways:

1) Assist Local War Council agencies to utilize and adapt to local needs the standard war training courses developed by the State Office of War Training.

2) Assist all Local War Council agencies in the necessary local adaptation, reproduction and distribution of training materials obtained from the State Office of War Training.

3) Assist the Chairman of the Local War Council and the local superintendent of schools in organizing and operating a course in general teaching methods for all civilian war instructors in the area served by the Committee.

4) Assist Local War Council agencies to utilize fully and effectively the Instructional and Informational Film Service of the State Office of War Training. Requests for films by all Local War Council agencies and civic groups should be reviewed from the standpoint of possible duplication and applicability to specific local war training and information problems and consolidated by the Local War Training Committee. The Local War Training Committee should then order and distribute locally, for all Local War Council agencies and civic groups, the films of the State Office of War Training. Such a centralized local system of reviewing and consolidating requests of Local War Council agencies and civic groups, booking and showing films, will provide maximum efficient use of such visual war training and information aids while they are in the area. The Committee

should also develop for its area a list of public and private film projectors and schedule their availability.

5) Assist in obtaining maximum effective local dissemination of all standard training course materials and aids of the State Office of War Training, including radio scripts and dramatic sketches having training value.

6) Assist in utilizing, with maximum effectiveness, the services of staff members of the State Office of War Training visiting on official business in areas served by Local War Training Committees.

7) Assist staff members of the State Office of War Training to establish or strengthen local service relationships in the area served by the Local War Training Committee.

8) Advise the State Office of War Training of outstanding local training accomplishments.

9) Make all local arrangements for regional and local training institutes, schools or conferences conducted by the State Office of War Training or by any other agency of the State War Council, in collaboration with the State Office of War Training.

10) Keep the State Office of War Training advised continuously of local training problems and needs through field relationships, written communications and regular monthly Committee reports.

M Serve as a local clearing house for training facilities and services of the U. S. Office of Civilian Defense in the following ways:

1) Assist Local War Council agencies to interpret and give effect to civilian war training regulations and requirements of the Office of Civilian Defense.

2) Assist Local War Council agencies to utilize and adapt for local needs training materials developed by the Office of Civilian Defense.

3) Assist Local War Council agencies in the reproduction and distribution of training materials developed by the Office of Civilian Defense.

4) Facilitate local preparation and dissemination of certificates of membership in the U. S. Citizens Defense Corps and the U. S. Citizens Service Corps.

5) Bring to the attention of Local War Council agencies information concerning the Civilian Protection Schools operated by the War Department and other war training schools conducted by the Office of Civilian Defense.

Each member of the Local War Training Committee should be assigned at least one of the foregoing functions. It is essential for the immediate successful operation of the Committee that the following Committee assignments be made at once.

1) One member to receive all course materials and arrange for adaptation, reproduction and distribution of these materials.

2) One member to receive and handle all films and act as a local source of information on films and film projectors.

3) One member to check continuously all local training records.

4) One member to handle all New York State War Council Certification.

Instructional Film Service.

Any State or Local War Council agency may borrow, without charge for rental, instructional and informational films to be used in their training programs. Films needed to supplement instruction in State or local training programs may be acquired through purchase, loan or gift by the Instructional Film Service. Local agencies should order their films through their local War Training Committees at least two weeks in advance of scheduled showing. (A complete, descriptive list of the subjects comprising the Office of War Training's library of instructional and informational films will be mailed upon request).

Through the cooperation of film units in the State Department of Conservation and the State Department of Health, the Office of War Training is able to assist in the production of new instructional films not otherwise obtainable from federal or private agencies.

Instructional Publications.

Publications of the U. S. Office of Civilian Defense, the U. S. Office of War Information and State Departments are also available through the State Office of War Training. There is no charge. City and County War Council agencies are invited to send us their instructional materials for review.

Publications issued. The handbooks and manuals already published by the State Office of War Training are listed below. They may be obtained through local War Training Committees, or by writing to the Office in Albany. Orders should be accompanied by a statement indicating the nature of training programs for which the publications are desired.

Publications issued by the Office of War Training, as of May 1, 1943, are:

1) *Instructor-Training Manual,* September 1942
   A suggested course in general teaching methods.
2) *Air Raid Warden Instructor's Manual,* October 1942
   Official New York State War Council basic course for Wardens.
3) *Air Raid Warden Manual of Tactics,* October 1942
   Exercises for drilling Wardens prepared by the New York City Air Warden Service.
4) *Civilian Defense Driver Instructor's Manual,* October 1942
   Official New York State War Council basic course in the operation and maintenance of motor vehicles under war conditions.
5) *Fire Defense Training, Basic Course,* Revised November 1942
   Revised Home Study Outlines for Basic Fire Defense Training Course for firemen and their auxiliaries.
6) *Plant Protection Survey Check-List,* November 1942
   Outline to achieve standardized plant protection surveys.
7) *Block Leader Service Instructor's Manual,* December 1942
   Official New York State War Council basic course.
8) *Fire Fighting,* December 1942
   A 256 page practical and illustrated guide for training firemen and their auxiliaries written by John J. McCarthy, Assistant Chief of Department, in command of the New York City Fire Department, and Chairman of the Curriculum Laboratory Committee of the State Fire Chiefs' Advisory Committee of the State Office of War Training. One copy was presented by the Office of War Training to each Fire Chief in the State. Extra copies may be obtained directly from the publisher, The Femack Company, 205 West 19th Street, New York City.
9) *Reactions of People Under Stress,* January 1943
   An instruction schedule prepared by State Department of Mental Hygiene for the Office of War Training to assist civilian war agencies to deal with problems of anxiety (fear and panic states), morale and fatigue.
10) *Local War Training Committee Handbook,* March 1943
   A Handbook on the organization and functions of local War Council War Training Committees.

11) *Sanitation and Water Works Manual,* March 1943
Official New York State War Council Basic Course used in both regional and local organization and training of Emergency Sanitation Services, Water Main Repair Crews, and Water Works Auxiliaries.

12) *Fire Department Rescue Squad Home Study Sheets,* March 1943
A series of six lessons for Fire Department Rescue Squads in the Erie-Niagara zone.

13) *Block Service Leader's Kit,* April 1943
A kit of reference material suggested for local adaptation, reproduction and distribution to each Block Service Leader. A "Message to Block Leaders" is signed by Governor Dewey and Mrs. Winthrop Pennock. An appendix is included to assist officers of the Block Service.

14) *Forest Fire Fighters Handbook,* May 1943
A guide for Forest Fire Fighters in handling forest, brush and grass fires.

15) *Fire Defense Training, Advanced Course,* May 1943
An outline of advanced training for firemen who have completed basic course.

Publications in Preparation. The following titles indicate publications of the Office of War Training on which the editorial work is in various stages of completion preliminary to approval by appropriate State War Council officials and reproduction:

Plant Protection Handbook
Complete assembly of instructional materials used by experts in the U. S. Army, the O. C. D., and industry at the regional Plant Protection Schools conducted by the Office of War Training. This Handbook is intended for industrial executives responsible for organizing and training plant protection personnel.

Instructional Film Service Handbook
Complete descriptive list of instructional and informational films distributed by the State Office of War Training, together with suggestions for effective use of training films.

Auxiliary Police Instructor's Manual
A reference text for instructors in training Auxiliary Police, Auxiliary Sheriffs and industrial protective forces in emergency wartime duties.

War Gas Protection Instructor's Manual

A reference text for instructors and local gas officers in giving basic training to selected civilian protection personnel in war gas protection methods.

Air Raid Warden Instructor's Manual, revised edition

October 1942 edition revised to include new data.

Block Leader Service Instructor's Manual, revised edition

December 1942 edition revised to include new data.

Rescue Squad Instructor's Manual

A reference text for instructors of Rescue Squads being trained to assist persons injured during bombing attacks.

Training Programs.

Any regular or emergency State or local governmental agency may have the assistance of the Office of War Training in organizing and administering its war training programs. The Office of War Training has assisted in developing, organizing and administering the following training programs:

Basic Fire Defense Training Program, Advanced Fire Defense Training Program, Organization and Training of Plant Protection Personnel, Plant Protection Schools for Executives

Training conducted at the request of: State War Plans Coordinator; State Director of Civilian Protection; State Fire Administrator; State Fire Defense Committee; Chairman, State Division of Industry, Agriculture and Labor; Chiefs of Local Fire Departments; Industrial executives of war industries, etc.

Air Raid Warden Training Program

Training conducted at the request of: State Director of Civilian Protection; City and County Directors of Civilian Protection; City and County War Training Committees; American Legion Civilian Defense Program.

Block Leader Service Training Program

Training conducted at the request of: State Office of Civilian Mobilization; City and County Chiefs of Block Leader Service; City and County Chairmen of Civilian War Services; City and County Chairmen of Civilian Mobilization.

Child Care Training Program

Assisted in producing instructional film at the request of State Child Care, Development and Protection Committee.

Civilian Defense Driver Corps Training Program, Pre-Induction Driving Program, School Bus Driver Training Program

Training conducted at the request of: State War Transportation Committee; Chairman, State Division of Industry, Agriculture and Labor; State Education Department; City and County Directors of Civilian Protection; City and County War Transportation Committees; City and County War Training Committees; American Women's Voluntary Service.

Emergency Water Service and Sanitation Training Program

Assisted in developing and publishing instructional text and film materials at the request of: State Coordinator of Water Supply; State Health Department.

Food and Drug Officials Gas Training Program

Training conducted at the request of: State Department of Agriculture and Markets; State Department of Health; State Gas Consultant.

War Gas Protection Training Program

Training conducted at the request of: State Gas Consultant; City and County Directors of Civilian Protection.

Instructor Training Program

Training conducted at the request of: State Coordinator of War Plans; City and County Directors of Civilian Protection; City and County Fire Chiefs; City and County Chairmen of Volunteer Offices; City and County Plant Protection industrial executives; City, County, and District Superintendents of Schools.

Library Aides' Training Program

Assisted in training program at request of: State Education Department, Division of Adult Education and Library Extension.

Milk Pasteurization Plant Superintendents Training Program

Assisted in training at request of: State Department of Health; State Coordinator of Emergency Milk Supply.

Physical Fitness Training Program

Assisted in producing instructional film at request of: State Office of Physical Fitness; State Department of Education, Division of Health and Physical Education.

Social Service Aides' Training Program

Assisted in developing program for: State Department of Social Welfare; State Office of Civilian Mobilization.

Staff.

The administrative staff of the Office of War Training operates in a flexible structure so that specialists assist one another to round out any training program. In addition, the Office calls upon outside experts to act as technical consultants for various training programs. The staff, as of May 1, 1943, includes:

Director, ALBERT H. HALL, who is on loan from the State Education Department where he is Chief of the Bureau of Public Service Training and Director of Public Employe and Civilian War Training.

Deputy Director, MILTON M. ENZER, formerly Assistant to the Deputy Commissioner of Education, State Education Department, and Assistant to the President of Union College, Schenectady; he is also Executive Secretary, Council of State Administrators for Defense Training and Placement.

Field Training Unit. In charge of coordinating all field training is WILLIAM D. WEITZ, Assistant Director, formerly a sales executive of the Standard Oil Company, and a supervisor in the Bureau of Industrial Service, State Education Department. There are five main fields in this unit:

Local War Training Committee Services which are under the direct supervision of MR. HALL, assisted by a Field Representative, EDWARD J. MALLIN.

Fire Defense and Plant Protection. Chief of training in this field is CAPTAIN EDWARD F. CURREN, formerly Chief of the Protection Engineering Department of the Underwriters Rating Board. He is assisted by Field Training Instructors W. LEWIS ARMSTRONG, FLOYD L. BROWN, HENRY F. DRAKE, HOWARD J. KEELER, and CHARLES F. VOGEL.

Civilian Protection (except fire). Chief of training in this field is WALTER J. FILE, formerly chairman of a local Civilian Defense Council. He is assisted by other members of the staff and by technical consultants.

Civilian War Services. Chief of training in this field is MR. ENZER, assisted by other members of the staff and by technical consultants.

Industry, Labor and Agriculture. Chief of training in this field, outside of vocational training for war industries, is Mr. Weitz, assisted by other members of the staff and technical consultants.

Assisting all sections of the Field Training Unit in the utilization of instructional films is a Field Training Projectionist, Gordon R. Mullins.

Instructional Materials Unit. Coordinating the work of this unit is the responsibility of Mr. Enzer.

George A. Roberts, as Constructor of Programs, is in charge of the Instructional Film Service, course construction, and war training certification.

Dorothy Guy Smith, as Editorial Assistant, assists Mr. Enzer in the writing and editing of all instructional publications.

William J. Wood, as Production Research Assistant, is in charge of the production of all instructional publications.

Roma C. Finzer, is the principal editorial stenographer.

Technical Consultants. Among the technical consultants are: John J. Jenkins, to assist in the acquisition and utilization of instructional films;

Dr. H. Beckett Lang, Assistant Commissioner of the State Department of Mental Hygiene, to assist in training programs with problems relating to the prevention of panic, etc.

Clerical Unit. Coordinating the work of this unit is the responsibility of Mr. Weitz. Peggy McEwan is office manager. Secretary to Mr. Hall is Mary Nerf. Jean Cox is the film booking clerk.

NEW YORK STATE

Mutual Aid Water Supply
Water Main Repair Program

Sanitation and Water Works Manual

for Organizing and Training Emergency Sanitation Services, Water Main Repair Crews, and Water Works Auxiliaries

A Publication of the **NEW YORK STATE WAR COUNCIL**

OFFICE OF WAR TRAINING

Administered by

tate Education Department, Bureau of Public Service Training

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